The Incentives of SPAC Sponsors[*]

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Abstract

This paper quantitatively studies the incentives of the sponsors of Special Purpose Acquisition Companies (SPACs) and their impact on SPAC investor welfare. We estimate a structural model featuring the strategic interactions between sponsors, targets, and investors using a hand-collected dataset with rich information such as sponsor concessions, earnouts, redemptions, etc. Agency costs appear pervasive: the inter-quintile range of returns reaches 19% for deals sorted on the extent of agency conflict. Tying more of the sponsor's promote to earnouts and improving information transparency each significantly improve investors' welfare, while curtailing the issuance of warrants yields only modest improvement.

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1 Introduction

Special Purpose Acquisition Companies (SPACs) have exploded in popularity in recent years. Created for the sole purpose of merging with a private company and taking it public, these publicly-traded blank-check companies were recently touted as the "hottest thing in finance" (*Wall Street Journal*, Jan 23rd, 2021) and have seemingly taken Wall Street by storm. Yet, as both the primary (i.e., initial public offering (IPO)) and the secondary equity market took a sharp downturn in 2022, many investors who clamoured to join the SPAC frenzy suddenly found themselves reeling from steep losses. Moreover, the roller coaster ride of SPACs has drawn intense scrutiny from regulators. Citing "heightened concerns about various aspects of the SPAC structure", the US Securities and Exchange Commission (SEC) has proposed a series of regulatory measures aimed at enhancing protections for SPAC shareholders. However, as the SEC noted in its proposal, "in many cases, we are unable to quantify the relative magnitudes of various economic effects because we lack information to quantify such effects with a reasonable degree of accuracy."[1]

This paper aims to close this gap by providing a comprehensive quantitative analysis of the main economic frictions in the SPAC market. In a typical SPAC, the manager, known as the SPAC sponsor, is delegated the responsibility of identifying a merger target and negotiating the terms of a possible deal. The sponsor then proposes a deal to the SPAC's investors, who get an up-or-down vote on the proposed deal, as well as an opportunity to redeem their shares for approximately the IPO price. If the deal is approved, the target takes over the SPAC's listing on the stock market in what has come to be known as the *de-SPAC*. This unique business model provides a useful laboratory for studying one of the fundamental issues in finance: the impact of asymmetric information and agency frictions on the welfare of investors. First, the sponsors, often managers of private equity, venture capital, or hedge funds, are likely far more informed about the true value and prospects of the target than are outside investors. Second, the sponsors and investors have divergent incentives for completing a deal. When the SPAC is formed, the sponsor

[1]Special Purpose Acquisition Companies, Shell Companies, and Projections, RIN 3235-AM90, Securities and Exchange Commission, March 30, 2022

buys a large stake, known as the sponsor's "promote", at a nominal cost.[2] The "promote" represents the primary compensation for the sponsor and can imply big payoffs in many circumstances but also some potential blow-back. In particular, for deals that perform poorly after the de-SPAC, the sponsors may still receive a windfall in the form of their promote shares while the SPAC shareholders suffer substantial losses. In contrast, if the SPAC fails to complete a deal within the allotted time (usually two years after its IPO), the SPAC is liquidated, outside investors are made whole, and SPAC sponsors get essentially nothing.

A recent lawsuit involving the SPAC, Churchill III (Ticker: CCXX), and its target Multiplan (Ticker: MPLN) highlights these frictions. MPLN is a leading healthcare payment processor with more than a billion dollars in annual revenue, and most notably counts UnitedHealth among its extensive client base. In 2020, CCXX and MPLN agreed to a deal that CCXX investors overwhelmingly approved, with fewer than 8% redeeming shares. Shortly after the deal closed, news emerged that UnitedHealth was developing an in-house substitute for the MPLN product, potentially impairing 35% of MPLN's future revenue. MPLN shares fell precipitously on this news. A shareholder lawsuit quickly followed alleging that the CCXX sponsor Michael Klein (and the original MPLN management) intentionally withheld this material information, impairing investors' redemption decision in order to reap a fortune for himself.[3]

CCXX-MPLN, along with a series of other notable cases involving high-profile SPACs and their targets (e.g., Nikola, Lucid Motors, Draft Kings, etc.), exemplify the pressing need for a deeper understanding of the various economic forces in the SPAC market. Estimating a model using a hand-collected, comprehensive dataset of SPACs and their targets over a long horizon, this paper quantifies the impact of two primary frictions in the SPAC market on the welfare of SPAC shareholders: the agency costs associated with

[2]SPAC sponsors usually pay just $25,000 for a stake engineered to be 25% of the SPAC's IPO shares, compared to the average hundreds of millions of dollars raised from SPAC shareholders.

[3]In a preliminary ruling on a motion to dismiss, the judge (Vice Chancellor Will) denied the motion, additionally ruling that Klein could not invoke the "business judgment rule", instead having to meet the much more onerous "entire fairness" standard in arguing that his actions were in the interest of shareholders. The judge stated that her ruling was based on the potential conflict between Klein and public shareholders resulting from their different incentives in a bad deal versus no deal being sufficient to pass the "reasonably conceivable" threshold. In spite of this rather harsh rebuke, the parties eventually agreed on a settlement of $33.75 million in November of 2022, with no admission of wrongdoing on the part of the defendants. The settlement awaits final court approval. See Court of Chancery, re Multiplan Corp Stockholders Litigation, C.A. No. 2021-0300-LWW (Jan 3, 2022).

the compensation structure of SPAC sponsors and the lack of information transparency. Using the estimated model as a laboratory, we further analyze the efficacy of several policies recently proposed by regulators and public commentators, and contribute to the ongoing debate over whether these policies will actually improve outcomes for investors.

In our model, the SPAC sponsor identifies a target company, whose owners have a reservation price for the business. The SPAC sponsor can increase the value of the target business by supplying cash and offering a public listing for the target, as well as other intangible benefits. We assume that the sponsor and target owners are equally informed about the target's prospects as a public company and split any surplus via bargaining. They negotiate and announce the deal terms that include the sponsor's stake, the target's ownership stake, and any additional capital raised externally (commonly known as a private investment in public equity, or a PIPE). SPAC shareholders, on the other hand, cannot directly observe deal quality and have to infer the de-SPAC returns based on the announced deal terms. They decide whether to redeem their shares at face value and earn a risk-free return, or see through the business combination and retain their ownership in the merged firm. If SPAC shareholders perceive dim prospects for a proposed deal, they are likely to redeem their shares, increasing the likelihood of deal failure.

Our model characterizes the sponsor's optimal choice of deal terms and the SPAC shareholders' optimal redemption decision, taking into account the strategic interaction between them. The sponsor trades off sweeter deal terms that favor himself (but hurt SPAC shareholders) against an increased risk of deal failure due to the intensified redemption associated with such terms. If the sponsor anticipates that the risk of deal failure overwhelms the benefits of reaping additional dollars in a completed deal, he can design deal terms that are more favorable to SPAC shareholders, potentially tipping the scales against redemption. The sponsor can alter the value he places on the target business by issuing fewer SPAC shares to the target owners and forfeiting a portion of his own compensation, as the bargaining protocol forces the target and the sponsor to share the cost. In contrast, SPAC shareholders calculate their expected returns from the proposed deal based on imperfect information, having to infer outcomes from the announced deal terms. Consequently, a pooling equilibrium emerges in which deal terms are only partially-revealing of deal fundamentals, implying that SPAC shareholders may err in their redemption decisions. Indeed, in the equilibrium of our model, some value-destroying deals may complete, while some value-enhancing deals may be abandoned. The agency friction between the SPAC sponsors and shareholders and the asymmetric information between the two parties are the key determinants of the overall efficiency of the SPAC market and the value split among various participants.

We bring the model to the data to gauge its quantitative implications. We assemble a comprehensive dataset of SPACs that registered for IPOs in 2009 or later and completed a business combination by March 31, 2022. One signature of our data that differentiates our work from previous studies is that our data contain detailed terms regarding sponsor compensation (forfeited promote shares and sponsor earnouts), external financing (e.g., forward purchase agreement (FPA), PIPE, etc), consideration offered to the target shareholders, and aggregate redemptions by SPAC shareholders. These features allow us to characterize and quantify the information and agency frictions inherent in the SPAC structure.

Our identification strategy starts with the observation that, in the model, as in the data, SPAC shareholders are able to partially infer deal quality based on observed deal terms. They use this inference to inform their redemption decisions, giving rise to a negative correlation between redemption and ex-post deal performance. The magnitude of the correlation allows us to assess the extent to which investors possess relevant information that enables them to make efficient redemption decisions. In addition, the empirical distribution of the sponsor's compensation scheme disciplines our estimate of the sponsor's associated agency cost. Intuitively, sponsors with low agency costs internalize the interest of SPAC shareholders to a greater extent, and are thus more likely to forfeit part of their compensation if the outcome benefits shareholders. We estimate the model by searching for the set of parameters that minimize the distance between the model-implied moments and the empirical moments constructed from the data. Our estimated model fits the data well, capable of closely matching the empirical distribution of deal terms, including the sponsor's compensation, the offer made to the target, and the external capital raised. The model is also able to reproduce the empirical patterns of cash retained in the SPAC firm, aggregate redemptions by SPAC shareholders, and ex-post deal performance.

Our estimates yield a few novel findings. First, agency costs are pervasive in the SPAC market. The empirical distribution of agency costs across different sponsors is best captured by a uniform distribution, meaning that for the average deal, it is difficult to infer ex-ante the extent to which the sponsor cares about SPAC shareholders. Comparing the deals in the lowest agency cost quintile with those in the highest quintile, we find that the difference in SPAC shareholders' expected returns averages 19 percentage points. This large difference is a joint consequence of more low-value deals being pushed through, and a larger fraction of the value creation accruing to the sponsor and target. In other words, in deals with greater agency costs, SPAC shareholders subsidize the sponsor and target, especially when deal quality is low.

Second, information asymmetry results in sizable forecast errors in the SPAC shareholders' inference of deal quality. These errors can be attributed to two main sources: first, deal quality is not fully revealed in a pooling equilibrium, which explains about 30% of the forecast errors. Second, SPAC shareholders exhibit bounded rationality that prevents them from extracting all the information embedded in the observed deal terms, accounting for about 60% of the forecast errors. The rest of the errors come from the covariance of these two channels. These findings corroborate regulators' concerns that SPAC investors may be unsophisticated; unable to make optimal investment decisions due to the combination of agency frictions and opaque information in the SPAC market.[4]

Using the estimated model as a laboratory, we evaluate the efficacy of certain regulatory changes recently proposed by the SEC and public commentators. We carry out these policy experiments by constructing counterfactual economies using the estimated model parameters. The first proposed policy is to tie the sponsor's promote stake to earnouts, shares that are canceled if the post de-SPAC stock price fails to reach a pre-determined level (i.e., the trigger price). Proponents of this policy argue that such performance-based compensation helps better align the interests of sponsors and shareholders. Indeed, we find that this proposal can significantly improve shareholder returns. Specifically, for every 10% increase in the fraction of sponsor promote tied to earnouts, the return to

[4]For example, the SEC noted in its proposal that "As a result of the complexity inherent in the SPAC structure, investors may lack or otherwise be unable to readily decipher critical information regarding certain financial incentives (such as contingent sponsor or IPO underwriter compensation or the potential dilutive effects of PIPE financing) of the SPAC, the target company, their respective affiliates, or other parties in a manner necessary to properly assess the value of an investment position."

shareholders increases by 1.8 percentage-points. This improvement is more pronounced for SPACs with high agency costs, bringing their performance closer to those with low agency costs. In other words, earnouts help curb the conflict of interest between SPAC sponsors and outside shareholders.

Our second policy experiment examines reducing the number of warrants issued in SPAC IPOs, since warrant exercise results in the issuance of new share and are hence dilutive. Advocates of this policy argue that cutting back warrants helps reduce dilution of the combined firm value and thus improves the returns to non-redeeming shareholders. However, we find the impact of reducing the use of warrants is far more muted: for every 10% reduction in the amount of warrants issued, the return to shareholders increases by only 0.28 percentage points. Moreover, cutting back warrants does little to mitigate agency costs, as the performance gap between the returns to shareholders under high and low agency costs actually widens. This is because the dilution associated with warrant exercise only matters when performance is strong, which is less likely when agency costs are high.

Finally, we evaluate policy proposals aimed at improving information transparency in the SPAC market, such as expanding mandated disclosure from sponsors. We find that SPAC investors can, on average, earn a 7.45 percentage-point higher return if the improvement of information transparency is sufficient to neutralize the forecast errors due to the investors' bounded rationality. The improvement arises primarily from helping investors make more informed redemption decisions. In particular, investors are much more likely to recognize and redeem when low-quality deals are proposed and, by doing so, avoid potentially hefty losses from these deals.

Our paper contributes to the growing body of research on SPACs, dating back to Lewellen (2009). However, these earlier studies are typically constrained by limited sample size and largely focus on the performance of the de-SPAC.[5] The recent surge in SPAC activities have inspired new work such as Blomkvist and Vulanovic (2020), Lin, Lu, Michaely, and Qin (2021), Blankespoor, Hendricks, Miller, and Stockbridge Jr (2022), Gahng, Ritter, and Zhang (2022), and Klausner, Ohlrogge, and Ruan (2022). Beyond

[5]See e.g., Lewellen (2009), Jenkinson and Sousa (2011), Cumming, Haß, and Schweizer (2014), Rodrigues and Stegemoller (2014), Kolb and Tykvova (2016), and Dimitrova (2017).

documenting post de-SPAC performance, these studies consider the costs of going public using a SPAC vs. an IPO, the role of Sponsor/Target projections, the performance pre and post de-SPAC for all SPAC unit components, and the networking effects. Meanwhile, on the theory front, recent studies explore specific features that lead to the rise of SPACs (Alti and Cohn, 2022; Gryglewicz, Hartman-Glaser, and Mayer, 2022) and their implications for investor returns (Banerjee and Szydlowski, 2022; Gofman and Yao, 2022; Luo and Sun, 2022). We contribute to this burgeoning literature by empirically quantifying the degree of agency frictions through the lens of a structural model. Using the model, we also perform counterfactuals to gauge investors' losses from the sponsors' agency conflict, as well as from the information frictions associated with observing the deal fundamentals.[6]

Our paper is also related to the literature that estimates the effect of information frictions and agency conflicts in the capital market. Albuquerque and Schroth (2010) quantify the private benefits of control in block trades, uncovering sizeable control benefits and significant value creation by controlling shareholders. Albuquerque and Schroth (2015) find that these controlling shareholders also suffer from a substantial illiquidity-spillover discount. Information frictions and agency costs also lead to sizable distortion in resource allocation. David, Hopenhayn, and Venkateswaran (2016) estimate substantial losses in productivity and output due to the informational friction, and Terry (2023) quantifies the aggregate implications of short-termism that discipline conflicted managers. Focusing on corporate takeovers, Celik, Tian, and Wang (2022) document sizable information frictions between acquiring firms and target firms, which can reduce the capitalized gain in this market by 60%; Wang and Wu (2020) find that managerial control benefits in takeover deals have both dark-side and bright-side effects on firm value. Our paper contributes to this strand of literature by focusing on the SPAC market. This market is unique in its structure and differs from the traditional takeover market in that information is more opaque, and the design of compensation packages of SPAC sponsors aggravates the agency conflict. Despite abundant anecdotal evidence, little is known regarding the magnitude of agency costs and the effect of information frictions in this

[6]Complementary to our work, Gofman and Yao (2022) document that the SPAC directors' network can present another important source of agency conflicts, and banning such network can lead to improvements in the welfare.

market. Our paper fills this gap by quantitatively assessing these frictions and analyzing the efficacy of proposed policies that look to tackle these challenges.

2 An Overview of the SPAC Mechanism

SPACs are blank check companies formed with the sole purpose of acquiring a private company. The sponsors of the SPAC file a registration statement with the SEC and engage an underwriter(s) for the purposes of going public as a shell company with no formal operations. SPACs go public as units rather than shares, with the structure of units near uniform: units are priced at $10 and consist of shares and fractional/whole out-of-the-money warrants. Warrants are typically struck 15% out of the money (which means $11.50 for all but a few cases) and expire five years after the SPAC completes a business combination.[7]

One of the unusual features of a SPAC is that it places essentially the entire proceeds from the IPO in a trust that the sponsors are unable to touch until they successfully complete an acquisition of sufficient size (called a "business combination") or they decide to liquidate. The SPAC has a limited timeframe within which to complete a business combination (usually 12-24 months), and any proposed business combination must be approved by SPAC shareholders. Finally, when the shareholders vote on a proposed business combination, shareholders retain the right to redeem their shares for roughly the IPO price or slightly above.[8] Any SPAC that fails to complete a business combination within the allotted timeframe will liquidate, with all IPO investors receiving their pro-rata share of the trust fund (typically 100%+ of the IPO price), and the sponsors getting nothing. Note that shareholders can redeem their shares but continue to hold their warrants.

Following the IPO, the sponsor initiates negotiations with numerous prospective targets about the possibility of a merger. If there is sufficient interest from both the sponsor

[7]The structure of SPACs varied considerably in the earliest generation of SPACs, but has been near uniform since 2009. Occasionally SPAC units include rights in addition to, or in lieu of, warrants. In such cases, representing about 10% of our sample, a unit includes the right to acquire 0.1 shares, with the rights converting to shares at the close of the business combination.

[8]In addition to voting on proposed deals, SPAC shareholders have to approve any extension of the SPAC's time horizon and can redeem shares when such votes are taken. As a result, SPAC sponsors often bribe shareholders to stay by increasing the size of the SPAC's trust (pool of cash available to fund redemptions) by a few cents per share.

and the target, the sponsor signs a non-disclosure agreement (NDA) and enters into formal negotiations with the prospective target. Here begins the due diligence phase, in which the sponsor is granted access to reams of private information in the hope of coming up with a valuation (and offer) that is high enough for the target owners to accept, and yet low enough for SPAC shareholders to refrain from redeeming their shares. It is critical that the sponsor exercises discretion over which businesses will make good investments, as well as determines an appropriate valuation of said businesses. Finding the best target at the right price is presumably how the sponsor justifies his compensation (the "promote" stake).[9] Since the sponsor acquires the promote stake for a nominal fee, the costs associated with said promote stake are borne by all other investors.

Finally, once the SPAC sponsor and the target firm's owners agree on the terms of a deal, they put together an investor presentation touting the merits of the target company's business and strategy and the strength of the SPAC team, as well as the terms of the deal, and it is up to the SPAC shareholders to approve the deal. While the technical approval of a deal is often a formality, the linchpin of the process is SPAC investors' stay-or-redeem decision. In this sense, the real voting on a proposed transaction is done with the feet rather than via the corporate ballot box.[10] Assuming the deal is approved, the target firm takes over the SPAC's listing while simultaneously changing the ticker symbol to better reflect the target firm's name and/or business. This process has come to be known as the "de-SPAC".

It is clear from the above description that SPAC sponsors are the critical cog in the entire SPAC/de-SPAC process, serving in a role somewhat akin to that of the underwriter in an IPO, but with a sizable stake in the ongoing enterprise. However, while the SPAC mechanism has the potential to be more efficient than a fixed price IPO, because the sponsor is privy to considerable private information and has a sizable stake in the ongoing business, the incentives of sponsors and SPAC shareholders are not well-aligned to the downside, creating the potential for costly agency problems. In light of these

[9] For certain sponsors there is also the possibility that the executive team of the SPAC can potentially add value through strategic or other insight.

[10] Specifically, in the extreme, should SPAC investors approve the proposed deal but at the same time all request to redeem their shares for cash, the SPAC will essentially become an empty shell, with no cash and only a public listing to offer target owners. Moreover, when redemptions are extremely high, there is a serious threat of being de-listed by the exchange due to an insufficient number of shareholders.

potential conflicts, sponsors may seek to pursue strategies and structures aimed at mollifying investors in an attempt to curtail potential redemptions. To this end, there are various actions the sponsor can take to make any proposed deal more attractive to the target firm's owners, the SPAC's outside investors, or both, potentially lessening apparent incentive conflicts.

First, the sponsor can raise additional capital for the business combination via a PIPE. This can make a proposed business combination more attractive to the target's owners by allowing the SPAC to offer more cash consideration to the target, or to provide more cash on the balance sheet of the ongoing (de-SPACed) business. Moreover, SPAC shareholders may be mollified by the participation of PIPE investors, and may therefore be less inclined to redeem their shares. Finally, the presence of the PIPE financing proceeds helps to provide a "backstop" against shareholder redemptions. At the same time, PIPE financing has costs and will dilute the gains of other investors should the SPAC perform well.

Second, the sponsors can reduce their own compensation. The sponsor's main source of compensation in the SPAC/de-SPAC process is the promote stake that they purchase at the outset for a nominal fee. The typical SPAC structure sets the promote stake to 25% of IPO shares, so that the sponsor will own 20% of SPAC shares prior to the business combination (i.e., 20% of the sum of IPO shares and sponsor promote). It is common that, during the course of the negotiation of SPAC terms, the sponsor will willingly forfeit a significant slice of their promote stake. Since the cost of the sponsor promote is borne by all other shareholders, the sponsor's willingness to forfeit a fraction of this stake is beneficial to all other shareholders, thereby making any proposed deal more attractive.

Third, rather than, or in addition to, forfeiting a portion of its promote stake, the sponsor can offer to tie the vesting of a fraction of the promote stake to certain performance metrics in what is known as an earnout. For example, with the value of shares defined to be $10 each, the sponsor may set conditions whereby a portion of the promote shares only vests if the post de-SPAC share price surpasses and remains above, say $15, for a period of time and within a period of time (typically 2-5 years). One can view an earnout applied to a given fraction of promote shares as analogous to forfeiting a significantly lesser fraction of the promote stake.

Finally, the sponsor must negotiate a valuation with the target owners. While it is conceivable that the sponsor proposes to buy the target firm outright using only the cash in the SPAC trust (and possibly additional cash raised in a PIPE), deals of this type are exceedingly rare. Instead, the SPAC offers the target owners consideration entirely or largely in the form of newly issued SPAC shares. The more shares issued to the target owners, the smaller is the stake of the SPAC shareholders, including the sponsor and any PIPE investors.

Ultimately, the sponsor presents a proposed acquisition (business combination) to the SPAC shareholders, including details that may incorporate many or all of the above actions taken by the sponsors. Then SPAC shareholders must decide whether to redeem their shares for cash, or retain their shares as an ownership stake in the ongoing (de-SPACed) enterprise, knowing that the sponsor's interests are unlikely to be perfectly aligned with their own and that there may be severe financial consequences for wrong choices. Our model of the SPAC mechanism, and associated sponsor actions, is intended to capture many of the aforementioned features.

3 Model

In this section, we set up the baseline model with the key features of SPACs introduced above. The model focuses on the de-SPAC stage, and it solves for the optimal deal terms chosen by the sponsor and target as well as the redemption decision made by the SPAC shareholders, highlighting the key frictions embedded in this process.

In our model, the number of units issued in SPAC IPOs is normalized to one. We also normalize the proceeds raised in SPAC IPOs to be 1, which implies the numeraire is 10 dollars. Each SPAC unit contains one common share and w warrants. w varies across SPACs, with common values being 0, $\frac{1}{5}$, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, $\frac{3}{4}$, or 1. For simplicity, we assume w is given for each deal. In other words, we abstract away from any decisions in the SPAC IPO process, and take the size of the IPO and the composition of each unit as given. These decisions are made before the SPAC sponsor meets a target and are thus less relevant for our objective of interest. Instead, we focus on the decisions surrounding the de-SPAC process, after the sponsor has found a target.

3.1 Value of the combined firm

In a proposed de-SPAC, the value of the combined firm is mainly determined by the amount of cash the SPAC brings to the deal and the value of the target firm post-merger. The cash brought in by the SPAC includes the amount of cash contributed by non-redeeming SPAC shareholders and the amount of cash raised externally through a PIPE and/or an FPA. Let δ denote the fraction of SPAC shares redeemed, then $1 - \delta$ dollars, contributed by the non-redeeming shareholders, is the cash in the SPAC trust net of redemptions. Also, if K denotes the cash raised externally, then the total cash that the SPAC brings to the deal is:

$$C = 1 - \delta + K, \tag{1}$$

We denote the value of the target firm as a standalone private entity, by u, and we assume that its value becomes $(1 + z) \cdot u$ if it merges with the SPAC. Therefore z can be viewed as the return created through merging with the SPAC. For instance, z can represent the gains from publicly listing the target firm or any value created by SPAC sponsors for the combined firm (e.g., sponsor's network, advise, etc.). Note that z may be negative in some deals, if, for example, a target prematurely lists its shares.

In addition, for SPACs that issue warrants in their IPO units, these warrants will be exercised if the post-deal stock price is above the strike price of the warrants, which is usually set to \$11.50 in the data (and thus 1.15 dollars in the model). If exercising, warrant holders pay $1.15 \cdot w$ dollars to the combined firm in exchange for w shares of ownership.

Adding up these components, we can write the value of the combined firm as:

$$V = C + (1 + z)u + 1.15 \cdot w \cdot \mathbf{1}_{\{p>1.15\}} - F, \tag{2}$$

where $\mathbf{1}_{\{p>1.15\}}$ is an indicator that equals one if the post-merger share price is above the strike and zero otherwise, and F is the total fee paid out including the underwriting fee and other fees.

3.2 Ownership of the combined firm

The combined firm value is split among different agents in the model, proportional to their ownership in the merged entity post de-SPAC. The non-redeeming SPAC shareholders own $1 - \delta$ shares. The external financiers (e.g., PIPE investors) own K shares.

A unique feature of SPACs is that, prior to the IPO, SPACs create promote shares, equal to 25% of the intended IPO shares, which the sponsors buy for a nominal fee. The sponsors initial stake therefore is 0.25 shares in our model. As we model formally below, sponsors sometimes have the incentive to willingly forfeit part of their promote, in the interest of mollifying shareholders, and thus we denote the sponsors' eventual ownership in the combined firm as $\theta \in [0, 0.25]$.

Finally, we assume that the target shareholders are offered n shares in the combined firm as compensation for the value they contribute to the deal. If exercising, warrant holders will own w shares.

The total number of shares in the combined firm post de-SPAC is thus equal to:

$$N = 1 - \delta + K + n + \theta + w \cdot \mathbf{1}_{\{p>1.15\}}, \tag{3}$$

Given the post de-SPAC firm value V and total shares outstanding N, the post de-SPAC share price is:

$$p = \frac{V}{N}, \tag{4}$$

The above accounting identity illustrates the potential sources of dilution to the non-redeeming shareholders' ownership in the combined firm. Clearly, the sponsor's promote shares θ add to the denominator but not to the numerator, and thus dilute firm value. Also, if exercising, warrant holders buy shares for 1.15 that are worth more than 1.15, causing additional dilution.

3.3 Decision makers

As shown above, the SPAC market involves various agents interacting with each other. To retain focus, we divide these agents into peripheral players (with simplified decision rules) and key decision makers. The peripheral players include the external financiers and warrant holders. We assume that the SPAC sponsor decides how much external capital to raise and the external financiers simply supply that, i.e., K is one of sponsor's controls, subject to a standard convex funding costs to be specified later. The warrant holders exercise optimally: exercise if and only if the warrants are in-the-money.

The key decision makers include the sponsor, the target, and the SPAC shareholders. The sponsor and the target negotiate the *deal terms* (θ, K, n), which consist of the sponsor's compensation θ, the capital raised externally K, and the offer made to target shareholders n. The payoff to the target is $n \cdot p$ if the deal completes and u if the deal breaks down. As a result, the target's gain from a completed de-SPAC is:

$$U_{tar} = n \cdot p - u, \tag{5}$$

The sponsor receives θ promote shares as his compensation, with the value of $\theta \cdot p$, if the deal completes. Since the sponsor is delegated the task of finding a good deal for the shareholders, he internalizes, at least to some extent, returns to shareholders. Meanwhile, if the sponsor raises external capital, he internalizes the performance of these shares as well. We thus specify the sponsor's gains from a completed de-SPAC as:

$$U_{sp} = \theta \cdot p + (1 - \ell) \cdot (1 - \delta) \cdot (p - 1) + (1 - \tau) \cdot K \cdot (p - 1) - \phi, \tag{6}$$

where ϕ represents the cost of raising external capital, given by:

$$\phi = \phi_1 K + \frac{\phi_2}{2} K^2, \tag{7}$$

and ℓ and τ capture the extent to which the sponsor ignores the gains/losses by the shareholders and external financiers, i.e., the misalignment of their interests or the agency costs. Both ℓ and τ take a value between zero and one, with a higher value indicating higher agency costs associated with the sponsor in making his decisions. For example, $\ell = 0.2$ implies that for each dollar lost by shareholders in the deal, the sponsor feels the pain of losing \$0.80. This approach of modeling the agent's utility with respect to the principal's gains/losses follows Taylor (2010) and Wang and Wu (2020). In the analysis henceforth, we set $\tau = 0$, because FPAs often represent investment tied to the wealth of the sponsor himself or his cronies, while PIPEs are provided by large institutional investors about whom the sponsor arguably cares more. In other words, we abstract away from any agency frictions between the sponsor and the external capital providers, and focus on modeling and calibrating the agency frictions between the sponsor and the SPAC investors. The determination of the optimal deal terms is detailed in Section 3.5 below.

SPAC shareholders decide whether to redeem their shares at face value or see through the business combination, aggregating to a fraction of δ shares redeemed.[11] The payoff to the shareholders is 1 if they redeem or if the deal fails, and $p - 1$ if they stay and the deal completes. The optimal choice of redemption is detailed in Section 3.6 below.

3.4 Information and timeline

In our model, each deal can be characterized as the triplet (ℓ, z, u), where ℓ captures the agency friction between the SPAC sponsor and the SPAC shareholders, z measures the synergy of the SPAC and the target, and u is the target's reservation value. The model takes this triplet as the state variables, which we refer to as the *deal fundamentals* henceforth. Deal fundamentals vary across deals and represent the key information asymmetry between the SPAC shareholders and the sponsor/target.

Specifically, we assume that both the sponsor and the target can observe the *realization* of the deal fundamentals, while the SPAC shareholders only know their common *distribution*, denoted by a probability density function $f(\ell, z, u)$. Meanwhile, the deal terms, (θ, K, n), are observable to all parties. In particular, shareholders use the observed deal terms and their knowledge about how those terms are chosen to infer the deal fundamentals, a process elaborated on below.

Figure 1 summarizes the timeline of the model. The information set possessed by each agent is marked in blue while the action set taken by the agent is marked in red. The de-SPAC process is divided into three phases. First, the sponsor approaches a target

[11] SPACs place all proceeds raised in their IPO in a trust account and invest them in money market funds to earn the risk-free rate. Upon redemption, each share is redeemed at \$10 plus the accrued interest rate. In the model, we normalize the risk-free rate to zero, so shares are redeemed at their face value of 1 dollar in the model.

firm, and they both observe the true value of (ℓ, z, u) of the deal. They negotiate the deal terms (θ, K, n) and then announce the deal to the public. The SPAC shareholders then decide whether to redeem their shares, aggregating to a fraction of δ shares being redeemed. Finally, nature determines whether the proposed de-SPAC completes or fails. We assume the probability of deal completion is

$$q(C) = q(1 - \delta + K) \tag{8}$$

for an increasing function (i.e., $q'(C) > 0$), provided that $U_{sp} + U_{tar} > 0$. In other words, the deal can only possibly complete when the total surplus to the sponsor and target is positive. The more cash brought to the deal by the SPAC, the more likely the deal completes. Once the deal completes, the true value of the combined firm, V, is realized and all agents get paid accordingly. If the total surplus is negative, the sponsor and target are better off canceling the deal. In such cases, the SPAC firm is liquidated and the target remains private.

The subsequent analysis assumes $U_{sp} + U_{tar} > 0$: that is, we focus on the deals for which there exists a set of deal terms such that the combined surplus to the sponsor and target is positive, and thus there is a positive probability that the deal completes.

3.5 Optimal deal terms

The optimal deal terms (θ^*, K^*, n^*) are chosen to maximize the sponsor and target's joint expected surplus from the de-SPAC, taking into account the probability of deal completion. That is,

$$(\theta^*, K^*, n^*) = \arg\max_{\theta, K, n} \quad \Pi(\theta, K, n), \tag{9}$$

where

$$\Pi(\theta, K, n) = (U_{tar} + U_{sp}) \cdot q(1 - \delta^* + K). \tag{10}$$

U_{tar} and U_{sp} are given by Equations 5 and 6, respectively. δ^* represents the sponsor and target's rational expectation of the aggregate redemption of SPAC shareholders, which we specify below. Let $\rho \in [0,1]$ denote the bargaining power of the sponsor and $1-\rho$ the bargaining power of the target, Nash bargaining and Equation (5) imply that:

$$n = \frac{1}{p} \cdot \left[u + (1-\rho) \cdot (U_{sp} + U_{tar})\right], \tag{11}$$

which is intuitive: given the per-share de-SPAC price p, the number of shares the target receives is higher if a) its intrinsic value u is higher; b) the sponsor and target's total surplus from the de-SPAC, $U_{sp} + U_{tar}$, is higher; and c) the target's bargaining power $1-\rho$ is higher. Both U_{sp} and U_{tar} also depend on the shareholders' redemption decision.

3.6 Shareholder redemption

Observing the deal terms, SPAC shareholders decide whether to redeem their shares or see through the de-SPAC. Obviously, the return to the staying shareholders depends on the deal fundamentals, which they do not observe directly and must infer from the deal terms. The shareholders then formulate rational expectations on the return from staying, given by:

$$\mathrm{E}[R_{sh}|\mathcal{F}] = \int_{\ell,z,u} p \cdot f(\ell, z, u|\mathcal{F}) d\ell dz du - 1, \tag{12}$$

where $\mathcal{F}$ represents the set of information available to the SPAC shareholders, and $f(\ell, z, u|\mathcal{F})$ the conditional density function of the deal fundamentals given such information.

To find the shareholders' redemption rate we need to specify two things: first, given $\mathrm{E}[R_{sh}|\mathcal{F}]$, when do the shareholders choose to stay versus redeem; and second, the shape of the conditional density function $f(\ell, z, u|\mathcal{F})$. The simplest approach would be to assume that each shareholder redeems as long as $\mathrm{E}[R_{sh}|\mathcal{F}] < 0$ and stays otherwise, where $f(\ell, z, u|\mathcal{F})$ is the conditional distribution of the deal fundamentals implied by the *exact* solution to the sponsor/target's optimization problem (Equation 9). This approach is confronted with two challenges in matching the data. First, the redemption decision in the model would be homogeneous among all SPAC shareholders, leading to a binary aggregate redemption rate of $\delta^* \in \{0, 1\}$ for all deals. However, aggregate redemptions are not binary in the data, with a significant fraction of deals having redemptions between 10% to 90%. This implies that our model needs to capture a significant degree of heterogeneity in redemptions. Second, shareholders in practice may not always be able to fully utilize the information embedded in the deal terms due to a lack of sophistication. Alternatively, shareholders may also receive a signal regarding the deal fundamentals that is not contained in the deal terms. Consequently, their inference of the deal fundamentals and the calculation of the return from staying can be more (or less) accurate than what is implied by the solution to Equation 9.

To address the first challenge, we follow the standard practice in the industrial organization literature and introduce latent heterogeneity in individual SPAC shareholder i's redemption decision by modeling it as a discrete choice:

$$\delta_i = \begin{cases} 0, & \text{if } \frac{\mathrm{E}[R_{sh}|\mathcal{F}]}{\sigma_\delta} + \epsilon_i > 0, \\ 1, & \text{Otherwise}, \end{cases} \tag{13}$$

where ϵ_i is an idiosyncratic shock drawn from an i.i.d. (standard) Gumbel distribution. This shock represents the latent demand by shareholders that drives the redemption decision beyond the expected return. Importantly, with this latent demand shock, investors' redemption decisions no longer follow a uniform threshold. This modification introduces a new parameter σ_δ to be estimated, which controls the importance of the latent demand shock. Equation 13 nests the simple, uniform redemption threshold rule if σ_δ approaches zero.

To address the second challenge, we incorporate two elements that allow the investors' inference about the deal fundamentals to differ from what the optimal deal terms (θ^*, K^*, n^*) would imply. The first is bounded rationality, which controls the degree of accuracy of shareholders' inferences. This is particularly relevant in the SPAC market right before the business combination, when a significant fraction of shares may be owned by investors lacking the necessary sophistication or financial knowledge to fully process the information embedded in the deal terms (Klausner, Ohlrogge, and Ruan, 2022).[12] Specifically, given the deal fundamentals (ℓ, z, u), for any combination of deal terms (θ, K, n),

[12] In a recent proposal, the SEC explicitly states that "In regard to de-SPAC transactions, investors could benefit from clearer dilution disclosure that takes into account the unique characteristics of the SPAC structure, including any terms negotiated with the target private operating company, as well as the potential for additional financing from PIPE investors... We are therefore proposing Item 1604(c) to require disclosure of each material potential source of additional dilution that non-redeeming shareholders may experience at different phases of the SPAC lifecycle".

we define a function $\zeta(\theta, K, n)$ as the probability that investors believe that (θ, K, n) are the optimal deal terms given (ℓ, z, u). Following Ben-Akiva, Litinas, and Tsunokawa (1985), we construct $\zeta(\theta, K, n)$ as

$$\zeta(\theta, K, n) = e^{\frac{\Delta\Pi}{\sigma_e}} \left(\int_{\theta,K,n} e^{\frac{\Delta\Pi}{\sigma_e}} d\theta dK dn \right)^{-1}, \tag{14}$$

where $\Delta\Pi = \Pi(\theta, K, n) - \Pi(\theta^*, K^*, n^*) \leq 0$ is the difference in the utility generated by (θ, K, n) and the utility generated by the optimal deal terms (θ^*, K^*, n^*). Intuitively, $\zeta(\theta, K, n)$ is lower when $\Delta\Pi$ is more negative, implying that the likelihood that the shareholders mistakenly recognize (θ, K, n) as the optimal deal terms under (ℓ, z, u) is smaller when the utility generated by (θ, K, n) is low. The parameter σ_e, controls the degree of this imperfect inference as a result of bounded rationality, and its value is to be estimated together with the other model parameters. A low value of σ_e implies more precise inference, and the limit $\sigma_e \to 0$ represents the case of perfect rationality, where the shareholders can always correctly infer the set of the deal fundamentals that generate the observed deal terms. Note that, even in the case of perfect rationality, shareholders may still not be able to infer the deal fundamentals with certainty. This is because there may be a pooling equilibrium under which multiple combinations of deal fundamentals generate the same optimal deal terms.

While bounded rationality introduces "mistakes" in shareholders' inferences of deal fundamentals, in reality, shareholders may also have more precise knowledge about the deal fundamentals than those inferred merely from the deal terms. To incorporate such possibility, we allow the shareholders to observe a signal s with precision η. Upon receiving the signal, shareholders update their knowledge about the distribution of the deal fundamentals from $f(\ell, z, u)$ to $f(\ell, z, u|s)$. The exact distribution of $f(\ell, z, u|s)$ will be specified later in Section 5, together with other distributional assumptions necessary for model estimation.

Putting everything together, the shareholders' conditional probability function given the deal terms (θ, K, n) and the signal s is:

$$f(\ell, z, u|\mathcal{F}) = \frac{f(\ell, z, u|s) \cdot \zeta(\theta, K, n)}{\int_{\ell,z,u} f(\ell, z, u|s) \cdot \zeta(\theta, K, n) \, d\ell dz du}. \tag{15}$$

Shareholders use Equation 15 to calculate $\mathrm{E}[R_{sh}|\mathcal{F}]$, the expected de-SPAC return following Equation 12.[13] Then, they decide whether to redeem their shares or stay based on their idiosyncratic latent shocks given in Equation 13. Aggregating individual shareholders' redemption decisions yields the total redemption rate:

$$\delta^* = \int_i \delta_i di = \left(1 + e^{\frac{\mathrm{E}[R_{sh}|\mathcal{F}]}{\sigma_\delta}}\right)^{-1}, \tag{16}$$

which eliminates the idiosyncratic shocks ϵ_i. Thus, while the sponsors cannot predict the redemption decision of an individual shareholder, they have rational expectations on how the deal terms they propose affect shareholders' calculation of the expected de-SPAC return and thus the amount of aggregate redemption the deal terms will trigger.

3.7 Equilibrium and model summary

We define the equilibrium of the model as the set of optimal decisions (the control variables) $(\theta^*, K^*, n^*, \delta^*)$ given the deal fundamentals (the state variables) (ℓ, z, u). The sponsor and the target jointly determine the sponsor's compensation, θ^*, the amount of external financing, K^*, and the shares given to the target, n^*, by solving Equation 9, taking into account how those choices affect the shareholders' aggregate redemption rate δ^*, given by Equation 16, and the deal completion likelihood q, given by Equation 8. Aggregate redemptions are the sum of individual redemptions as in Equation 13, given the observed deal terms and the implied deal fundamentals, subject to bounded rationality (the degree of which is captured by σ_e) or the signal s (with precision η).

In sum, our model highlights two frictions between the sponsor and the shareholders: first, the lack of alignment of the interests of the two parties captured by the state variable ℓ. Second, the information asymmetry between the two parties regarding ℓ and the other deal fundamentals (z, u). Under these frictions, the sponsor faces a tradeoff in choosing the optimal deal terms. More lucrative compensation for himself and a generous offer to

[13] Note that because $\zeta(\theta, K, n) > 0$ for all (θ, K, n), Equation 15 provides a complete set of beliefs for all possible observations of the deal terms. Therefore, $\mathrm{E}[R_{sh}|\mathcal{F}]$ is uniquely determined even when the observed deal terms are "off-the-equilibrium" (i.e., not optimal under any combinations of deal fundamentals) or if the equilibrium is pooling (i.e., multiple combinations of deal fundamentals yield the same optimal deal terms). It also ensures that any equilibrium we find is globally incentive compatible, because the sponsor can calculate his utility from proposing any alternative deal terms (i.e, from any deviation).

the target (i.e., high θ and n) increases their joint surplus in a completed deal. Meanwhile, such deal terms may dissuade SPAC shareholders from participating and result in more redemptions, reducing the likelihood of deal completion, as well as the pool of cash. External capital can help increase the SPAC's cash pool but is costly, and any losses the external financiers suffer from bad deals are fully internalized by the sponsor. Thus, the sponsor balances a larger gain in a completed deal versus a lower likelihood of deal completion. There may exist a pooling equilibrium in which multiple combinations of deal fundamentals yield the same deal terms, complicating the shareholders' inference and leading to inefficient redemption decisions.

Because the model is highly non-linear with multiple state and control variables, we proceed to solve it numerically and describe the details of the numerical algorithm in the Online Appendix A.

3.8 Model discussion

As in all models, we make a few simplifying assumptions that inevitably leave out certain features of the SPAC market. Here we discuss their implications.

First, we do not explicitly model the possibility of repeated deals by the same sponsor and any associated reputational effects. Naturally, sponsors who flagrantly take advantage of shareholders incur significant reputational costs, implying that reputational concerns could help mitigate the agency friction. Our model partially captures this through the parameter ℓ. Sponsors with low ℓ (i.e., low agency conflict) can be interpreted as those that care more about their reputations, implicitly placing more weight on shareholder returns.

Similarly, our model does not emphasize the timing of the de-SPAC within the given SPAC's life cycle. Intuitively, as SPACs approach their deadlines to complete a deal (usually 1.5 to 2 years post IPO), the sponsors have stronger incentives to complete a de-SPAC, even on unfavourable terms, aggravating the agency conflict. This effect is also implicitly reflected in ℓ. A high ℓ can be driven by the time pressure faced by the sponsor.[14]

[14]Admittedly, the timing of the de-SPAC is observable to shareholders. However, this timing is equivalent to a public signal about the deal fundamentals (which includes ℓ), which our model allows.

In sum, while we adopt a single parameter, ℓ, to capture the agency costs associated with a sponsor in reduced form, we do not take a stance on the source of the associated agency conflict, be it the sponsor's selfishness, reputational concerns, time pressure, or some alternative. The exact source of the agency conflict does not fundamentally affect the estimation or the implications of our model, because they are all captured by the degree to which sponsors internalize shareholder welfare.

Another potential conflict of interest in SPACs is that identifying a good target at a fair price takes considerable effort from the sponsor, yet such effort is not easily observable. If shirking is common in this market, then ℓ could be (negatively) correlated with deal synergy, z. While we cannot rule out the possibility of shirking, we believe it is unlikely to be a first-order concern given the sponsor's substantial stake in the deal. Moreover, the correlation between ℓ and z is not ex-ante obvious, because it is unclear whether a sponsor capable of finding good targets would necessarily also care more (or less) about the shareholders' welfare, as evidenced by the CCXX-MLPN case.

Importantly, our model is not designed to explain trends and cycles in the SPAC market. Irrespective of the cycle, which is largely driven by the dynamics in the primary and secondary equity markets, the main frictions that we aim to capture are intrinsic to the compensation structure of a SPAC, which has remained relatively stable during our sample period.[15] We also mitigate the impact of market fluctuation by using risk-adjusted returns to measure performance, which reflect the shareholder payoffs from not redeeming, relative to the performance of an equity index with a similar risk profile.

Finally, to focus on the frictions between the sponsors and shareholders, we do not model information asymmetry between the sponsor and the target. Given the sponsors' professional knowledge, the resources they can spend on researching targets, and a signed NDA, such information asymmetry is likely much smaller than that between the sponsor and shareholders. We also define the return to non-redeeming shareholders based on the redemption price rather than the purchase price. This is because our model characterizes the shareholders' redemption decision, while the purchase price is a sunk cost. The return

[15] The structure of SPAC units and the sponsor's promote have been essentially unchanged since the 2008-09 financial crisis, the period corresponding with our dataset.

from staying should be measured against the alternative (i.e., redemption). The purchase price itself is irrelevant.

4 Data

Our sample consists of 344 SPACs that registered for an IPO in 2009 or later, and completed a business combination by March 31st, 2022. Our final dataset contains 88% of all SPACs that registered and completed a business combination in this period. For each SPAC we rely on several sources to gather its information, much of which has to be meticulously gleaned by going through individual SEC filings and their associated attachments.

Specifically, we gather information about SPAC IPOs from the registration statement, the prospectus, and any Form 8-K filed shortly after the IPO. These include information on the size of the offering, the exercise (or not) of the over-allotment option, the structure of a SPAC unit, the nature and amount of external capital that enhances the cash raised in the IPO, the identities of the sponsor and other SPAC participants, the geographic or sector focus of the search for a target, etc.

Once the SPAC finds a target and signs an NDA, the SPAC typically announces the deal and terms and posts an investor presentation, all within or attached to a Form 8-K. These features allow us to view the terms of eventual deals at the time they are announced. We obtain the final terms of the deal in the "Super 8-Ks" that are filed shortly after the deal closes. From these filings, we are able to gather various deal-specific variables. The Super 8-Ks often contain various attachments including a press release, a condensed pro-forma financial statement, sponsor agreements, shareholder agreements, etc., in addition to the 8-K filing itself, any of which can potentially contain useful information. We use these filings to gather information on sponsor and target earnouts, any forfeited promote shares or sponsor warrants, information about the consideration paid in the deal, as well as any PIPE, FPA, or backstop financing raised through the unregistered sale of securities.

We obtain information on redemptions primarily from the Gritstone SPAC research database. This database covers the vast majority of the SPACs we analyze, including not only redemptions occurring at the time of the business combination vote, but also redemptions occurring prior to that vote. For deals outside of Gritstone's coverage, we find the redemption information from the aforementioned Super 8-Ks.

Finally, we obtain pricing data mainly from the Center for Research in Security Prices (CRSP). Our primary performance metric is to compute a 3-month post de-SPAC return relative to the baseline $10 redemption price, because in our model, as in practice, SPAC shareholders must choose between redeeming their shares for cash, and retaining shares post de-SPAC. We supplement the pricing data with alternative sources (e.g., Yahoo Finance or WRDS OTC End-of-Day Pricing database, etc.) as much as possible if such information is missing from CRSP. Given that most SPAC targets are small growth firms, we use the return on the iShares Russell 2000 growth ETF index (IWO) to calculate the post de-SPAC risk-adjusted return (alpha). That is, we measure the de-SPAC performance (R_{sh}) as

$$R_{sh} = \frac{P_{3m} - 10}{10} - R_{IWO} \tag{17}$$

where P_{3m} is the 3-month post de-SPAC share price, and R_{IWO} is the return to IWO during the same period. For robustness, we also consider 1-month and 6-month post de-SPAC returns, as well as using the Renaissance International IPO ETF index (IPOS) as an alternative benchmark for risk-adjustment. We find similar results in all these exercises.

Altogether, after assembling all the data, our sample contains 344 SPACs with complete information for our estimation. Figure 3 illustrates the distribution of deal completion by year in our sample. Most of the deals were completed during 2020 and 2021, with the trend continuing into Q1 of 2022. Deals completed in recent years are on average larger than their predecessors, reflecting the rapid expansion of the SPAC market.

In order to put variables on the same terms as our model set-up, we perform normalizations and make some adjustments. We normalize the proceeds of the SPAC IPO and the number of IPO shares to be one, so in testing the model, we normalize variables such as the external capital raised, by the proceeds of the IPO, so that such variables are stated in multiples of IPO quantity (in terms of both dollars and shares). This normalization is applied to PIPEs and other external capital, shares paid as consideration to the target owners, redemptions, and sponsor stakes. Meanwhile, our model assumes that all SPAC mergers only use shares as consideration paid to the target shareholders. However, in practice, a small fraction of deals in our sample involve significant cash consideration. We make the following adjustment to accommodate cash consideration. We divide the cash consideration by the price at the end of the performance period (3 months in our base case), to get a cash-equivalent number of shares. This allows us to convert cash consideration to shares, yet leave all parties' returns unaffected by the adjustment. Note that these adjustments tend to be minor, with less than 10% of our sample having majority consideration in cash. Details of the variable construction, including these adjustments, can be found in Online Appendix B.

Table 1 provides summary statistics on assorted variables of interest. Panel A provides the raw data, and Panel B provides summary statistics on a subset of the same variables, with their values scaled by the number of IPO shares (or dollar amount of IPO proceeds), to better align with our model. Most notably, while polarized redemptions (those more than 90% or less than 10% of the IPO shares) are common, a significant fraction of the deals have a moderate level of redemption, that varies substantially across deals. Meanwhile, the observed compensation to the sponsors (i.e., promote stake retained) is much more uniform. The sponsors retain the standard 25% promote shares in more than half of the deals. In cases where they do forfeit some of their promote shares, the concessions are usually small, as indicated by the low standard deviation. These patterns in the data are vital for the estimation of our model, which we discuss in the next section.

5 Model Estimation

In order to bring the model to the data, we make the following assumptions regarding the distribution of state variables and the functional form of the likelihood of deal completion.

1. $1+z$ and u follow log-normal distributions that are independent of each other, i.e., $\ln(1+z) \sim N(\mu_z, \sigma_z^2)$ and $\ln(u) \sim N(\mu_u, \sigma_u^2)$.

2. ℓ follows a Beta distribution $\ell \sim B(\alpha, \beta)$, independent of z and u.[16]

3. The signal $s = (1 + z) \cdot u \cdot \nu$, where ν follows a log-normal distribution with mean 1. That is, $\ln s \sim N(\ln(1 + z) + \ln(u), \sigma_s^2)$, where $\sigma_s^2 \geq \sigma_z^2 + \sigma_u^2$. We define $\eta = [\sigma_s^2 - (\sigma_z^2 + \sigma_u^2)]^{-1}$ as the precision of the signal. The higher η is, the more informative the signal is in predicting the value of the combined firm after de-SPAC.

4. The likelihood of deal completion $q(C) = \frac{1}{1+e^{-\gamma(C-\lambda)}}$. Here, λ determines the likelihood of deal completion when $C = 0$ (no cash from SPAC), and $\gamma > 0$ measures the sensitivity of deal completion rate to the cash brought by the SPAC.[17]

The model solution depends on the number of warrants issued in SPAC IPOs (as part of the units). To produce the panel of SPAC deals when simulating the model, we first solve the model for different numbers of warrants per unit issued, w. Then we simulate the model to generate a panel of SPAC firms with their numbers of warrants w equal to the empirical distribution obtained from the data. As shown in Figure 2, the most common number of warrants issued in each unit are 1/3, 1/2, and 1, and there are also a few SPACs with no warrants, as well as 1/5, 1/4, or 3/4 warrants in each unit. Our simulated data replicates this empirical distribution.

5.1 Identification

There are 13 model parameters to estimate: ϕ_1 and ϕ_2, which measure the costs of raising external capital; α and β, which characterize the Beta distribution of ℓ; μ_z, μ_u, σ_z, and σ_u, which correspond to the mean and standard deviation of the normal distribution for $\ln(1+z)$ and $\ln(u)$; γ and λ, which govern the probability of deal completion; σ_δ, which captures the variation of latent demand shocks across SPAC shareholders' redemption decisions; σ_e, which determines the extent of bounded rationality by SPAC shareholders, and η, which represents the precision of the signal received by SPAC shareholders. Below we discuss the data moments used to estimate these parameters.

[16]The Beta distribution has support of $[0, 1]$ that conforms to the definition of ℓ in our model. It also nests a few common distributions such as the uniform distribution and exponential distribution, thus providing much flexibility to match the data.

[17]Though cash is often an important consideration, some actual de-SPAC deals close without much cash (i.e., with high redemptions and no PIPE). In these deals, the targets' main interest is likely to list their shares as opposed to raising cash. In our model, the parameter λ determines the likelihood of deal completion when $C = 0$.

First, the distribution of external capital raised, K, is highly informative of ϕ_1 and ϕ_2. A high variable cost makes it more costly to raise external capital and thus decreases the average value of K in the data. Meanwhile, a high convexity, ϕ_2, means it is particularly expensive to raise large amounts of external capital and thus flattens the right tail of K.

Second, the sponsor's agency cost measure, ℓ, has a large impact on the distribution of the sponsor's compensation, θ. Intuitively, if the agency cost is low, the sponsor has less incentive to transfer wealth from SPAC shareholders to himself and is thus more willing to take lower compensation, θ, especially when retaining cash is critical to the probability of deal completion. Therefore, the mean and standard deviation of θ in the data help pin down α and β.

Third, the value of the target as a private entity, u, serves as the target's reservation price in the deal. Thus, the larger the private target, the more shares (or larger fraction) of the combined firm will be allocated to them as consideration. The distribution of the number of shares offered to the target, n (or as a fraction of the combined firm, $\frac{n}{N}$) reveals considerable information regarding the distribution of u. We use the mean and standard deviation of $\frac{n}{N}$ to discipline the estimates of μ_u and σ_u.

Fourth, total gains from the merger are created via z, which are then shared among all agents in the deal. The combined firm's stock price relative to the face value of SPAC shares (normalized to 1 in the model and \$10 in the data) reflects this piece of information. We compute the deal return and use its mean and standard deviation across deals to infer the cross-sectional distribution of z.

Fifth, the parameter σ_δ is introduced to generate a non-polarized redemption ratio. A small σ_δ implies a bimodal redemption rate, close to either zero or one, while a large σ_δ results in a broad range of redemption rates. We use the fraction of deals with a redemption rate falling between 10-90% to identify σ_δ, with a higher fraction implying a greater value of σ_δ.

Sixth, the magnitude of information asymmetry between SPAC shareholders and the sponsor/target determines the correlation between the shareholders' redemption decision and their returns. A low degree of information asymmetry means that shareholders can better infer the deal fundamentals and make more accurate redemption decisions. In the model, the two parameters σ_e and η drive the information asymmetry in opposite directions, and thus cannot be identified separately. Consequently, we assume that only one of them can be active and estimate their joint effect. Specifically, we first set $\sigma_e = \eta = 0$, and calculate the model-implied correlation between redemption and de-SPAC return. This benchmark correlation corresponds to the case in which the SPAC shareholders neither suffer from bounded rationality nor receive additional signals about the deal fundamentals. Then, we compare this model-implied correlation with the actual correlation between redemption and de-SPAC return in the data. If the model-implied correlation is more negative than that in the data, we set $\eta = 0$ and estimate σ_e. If the model implied correlation is less negative than that in the data, we set $\sigma_e = 0$ and estimate η.

The last two parameters, λ and γ, control the likelihood of de-SPAC completion rate. To identify λ, the baseline probability of deal completion without cash from the SPAC (i.e., $C = 0$), we use the fraction of completed deals that deliver a low cash amount (lower than 50% of the SPAC IPO size). If λ is large, we expect to see a smaller fraction of deals with low cash, and vice versa. We estimate two additional moments: the fraction of completed deals that deliver a medium amount of cash (130%-170%), and the fraction of completed deals that deliver a high amount of cash (above 230%), to identify γ, the sensitivity of deal completion rate with respect to the cash amount delivered. Intuitively, the frequency of deals with medium and high cash amount is more informative of the marginal value of cash on the deal completion rate relative to the frequency of deals with little or no cash.[18]

5.2 Model fit and estimated parameters

Given the above identification strategies, we apply the simulated method of moments (SMM) to find the value for each parameter. We simulate a cross-section of SPAC deals, compute their aggregate moments, and search for the parameters that minimize the distance between the model-implied moments and the corresponding data moments. Table 2 shows that the model does a decent job matching the target moments. Notably, the

[18]Note that the likelihood of deal completion with different amounts of cash is also influenced by other model parameters, including the distribution of z, u, and the cost of raising external capital ϕ_1 and ϕ_2. These parameters are mainly identified based on other moments discussed above. Consequently, λ and γ are the important determinants remaining. For instance, if we increase λ from its estimated value of 0.15 to a counterfactual value of 1, then the fraction of completed deals with low cash will be almost halved.

model generates a negative correlation between redemption and de-SPAC returns that is quantitatively similar to that observed in the data. Figure 4 illustrates such correlation in the data. The coefficient from a univariate regression of redemption rate on the de-SPAC returns is -0.272 and is statistically significant, with an R-squared of 23%. Note that the magnitude of this correlation reflects the degree to which SPAC shareholders are able to infer de-SPAC returns based on the observed deal terms. We elaborate on this below.

To further validate the model fit, we compare the model-implied *distribution* of the observables (θ, K, $\frac{n}{N}$, δ, C, and R_{sh}) with their actual distributions in the data in Figure 5. It is worth noting that while we estimate the model parameters by matching the moments (mainly first- and second-order) described in the previous section, a good match to these target moments does *not* guarantee a good match of the entire distribution, which is more sensitive to the underlying economic mechanism. In other words, matching the distributions of the outcome variables represents a much higher standard of quality for the model. Figure 5 shows that the model is able to generate distributions that match these distributions closely, further validating that the mechanism of the model captures the main underlying mechanism of the actual SPAC market.

Table 3 reports the estimated values of the parameters. The estimated deal quality, z, shows that the average value-creation from de-SPACs is about 5% of the target's intrinsic value. Considering that targets in de-SPAC are often much larger than their acquirers (i.e., SPAC), this value-creation is equivalent to about 1-2% of the combined firm's value, which is slightly lower than, but broadly consistent with, the average value-creation found in the M&A literature for more standard deals. Moreover, by construction, SPAC acquisitions do not generate operational synergies. Thus, for SPACs, value-creation primarily reflects the gain from a public listing, and any value associated with the cash that the SPAC brings to the deal. Our estimate also suggests that the cross-sectional uncertainty in value-creation is quite large, with a standard deviation of 28%. Meanwhile, there is considerable variation in u, the target firm's intrinsic value as a private entity. Overall, there appears to be substantial uncertainty regarding the value of SPAC deals.

Interestingly, even though we allow a very flexible Beta distribution in characterizing the degree of agency friction, ℓ, our estimate suggests that the two parameters that govern the Beta distribution, α and β, are indifferent from 1. In other words, the *uniform* *distribution*, a special case of the Beta distribution when $\alpha = \beta = 1$, fit the data rather well. A special property of the uniform distribution is that it generates the maximal level of ex-ante uncertainty regarding the value of ℓ, implying considerable challenges for SPAC shareholders in gauging the extent to which a sponsor internalizes their welfare.

Our estimate of σ_e, the parameter that represents the bounded rationality of SPAC shareholders, is 0.156. As explained earlier, a positive σ_e implies η, the precision of the signal, is set to zero. In other words, while the model incorporates both private signals and bounded rationality, to allow the shareholders to make better or worse inferences of the deal fundamentals than that based solely on the observable deal terms, the model estimate suggests that the net effect is in the direction of bounded rationality. This finding is consistent with the notion that SPAC investors are unsophisticated and do not always make the best redemption decisions. In particular, the correlation between redemption and de-SPAC return (-0.272 in the data) would have been more negative, if the average SPAC shareholder were more capable of utilizing the information embedded in the observed deal terms to formulate a forecast of the de-SPAC return.

Our estimate of σ_δ, the parameter that controls the variation of latent demand shocks in SPAC shareholders' redemption decisions, is 0.095. This observation suggests that when the redemption rate is close to the sample mean of 0.5, the sensitivity of the redemption rate with respect to the SPAC shareholders' perceived return $E\left[R_{sh}|\mathcal{F}\right]$ is -2.63. In other words, the redemption rate would increase by 2.63 percentage points for each percentage point decline in the perceived return.[19] While the sponsors partially mitigate the impact of redemption by raising external capital, the cost of doing so appears to be highly convex. The marginal cost of raising an additional dollar externally is only 2 cents per dollar at the 25th percentile of K, but it climbs up to 10 cents per dollar as the amount of external capital raised increases to the 75th percentile. Finally, our estimate of the deal completion function shows that $\lambda = 0.15$ and $\gamma = 1.25$, which suggests that, if zero cash is delivered to the target at de-SPAC, the likelihood of closing the deal is

[19]This is derived by taking the derivative of δ^* in Equation (16) with respect to $E\left[R_{sh}|\mathcal{F}\right]$:

$$\frac{d\delta^*}{dE\left[R_{sh}|\mathcal{F}\right]} = -\delta^* \cdot (1 - \delta^*) \cdot \frac{1}{\sigma_\delta}$$

and substituting in $\bar{\delta^*} = 0.5$ and $\sigma_\delta = 0.095$.

only 45%, and this likelihood increases to almost 80% when the cash amount delivered in de-SPAC reaches the sample mean.

Overall, the parameter estimates show that the fundamentals of SPAC deals (ℓ, z, and u), exhibit large variation, presenting a substantial degree of uncertainty to SPAC shareholders. Meanwhile, the average shareholder appears to be unsophisticated, making less precise inferences of the deal fundamentals than that implied by the deal terms. We analyze and quantify the impact of these findings on the shareholders' welfare in the next section.

6 Model Implications

Using the estimated model as a laboratory, we explore the implications of two sources of frictions in the SPAC market on the welfare of SPAC shareholders: agency conflict, as measured by the degree to which sponsors internalize the shareholders' gain/loss in their own decisions (Section 6.1), and the asymmetry of information between sponsors/targets and shareholders regarding the deal fundamentals (Section 6.2).

6.1 Agency costs

In our model, the degree of agency friction for each deal is captured by the parameter $\ell \in [0, 1]$, with higher ℓ representing more friction. We can estimate the overall distribution of ℓ by matching specific moments of the data, but there is no feasible strategy that allows us to assign a particular ℓ for each observed deal. Thus, to gauge the impact of agency frictions on the welfare of SPAC shareholders, we construct a simulated sample of SPAC deals using the parameters estimated in the previous section.

Specifically, we simulate 1,000 SPAC deals, each with an ℓ drawn from the estimated $B(1, 1)$ (i.e., uniform) distribution (and other parameters drawn from their estimated distributions respectively). We then partition the simulated sample into quintiles based on ℓ. Figure 6 compares the distribution of returns to SPAC shareholders in deals with low ℓ (bottom quintile) and high ℓ (top quintile). Agency costs appear to be substantial: when the agency conflict is high, a large fraction of deals produce negative returns for SPAC shareholders, with the 25th percentile of returns being a whopping -45%. When the agency conflict is low, most deals generate a positive return, and the 25th percentile of returns is significantly higher at +3%.

Next, we explore the mechanisms driving the agency costs. The conflict of interests between the sponsor and SPAC shareholders is particularly strong in inferior deals with low value-added. This is because, as z is low, the deal is unable to generate sufficient gains to compensate for the premium paid to the target and the dilution brought about by the sponsor's promote stake. In this case, SPAC shareholders would benefit if the proposed deal were called off. However, because the promote stake of the sponsor pays off only when the proposed de-SPAC completes, the sponsor has a strong inherent incentive to push the deal through. In other words, the interests of the sponsors and the shareholders are intrinsically misaligned when the deal quality is low. Such misalignment can be partially mitigated if the sponsors internalize the shareholders' welfare to a greater extent in their own decisions. Therefore, we can infer the source of the agency cost by comparing the value-added, z, in deals with low agency conflict and those with high agency conflict. Panel A of Figure 7 shows that z is significantly lower in deals with high agency conflict. This is particularly true for deals with negative z: these value-destroying deals show up mainly in the group of sponsors with high ℓ. It is worth noting that the unconditional distribution of deal quality, z, is independent of ℓ, and therefore this negative correlation between z and ℓ in observed deals is a manifestation of an endogenous selection effect: low-value deals are more likely completed by sponsors who internalize less of the shareholders' welfare. In other words, agency frictions affect the composition of completed deals.

Agency frictions also affect how the surplus is divided. Sponsors with low ℓ are more willing to give up part of their compensation to reduce the dilution of firm value and thus make the deal sweeter for SPAC shareholders. In panel B of Figure 7, we plot the distribution of sponsor compensation, θ, for deals with top- and bottom-quintile ℓ. Sponsors with high ℓ rarely give up any of their promote stake. Thus, a large fraction of these deals have the industry-standard θ of 0.25. The fraction of shares they give up is also small in the rare instances when they choose to do so. In contrast, sponsors with low ℓ are more likely to give up large portions of their promote stake. In fact, in about 20% of deals proposed by these sponsors, they reduce their θ from 0.25 to below 0.05.

Overall, our analysis demonstrates that the agency conflicts between SPAC sponsors and shareholders have a substantial impact on the shareholders' returns from the de-SPAC. Sponsors that internalize less of the shareholders' welfare are more eager to push through low-quality deals and less willing to forfeit much, if any, of their promote stake. The combination of these two factors implies that shareholders are effectively subsidizing the sponsors and targets in these deals, resulting in low, and often negative, returns from the de-SPAC.

6.2 Information asymmetry

In the model, rather than observing the deal fundamentals, SPAC shareholders have to infer the fundamentals from the announced deal terms. The resulting information asymmetry influences shareholders' conjecture of the de-SPAC return, or $E\left[R_{sh}|\mathcal{F}\right]$. To gauge the degree to which information asymmetry affects the shareholders' inference, we perform the following variance decomposition:

$$Var\left(R_{sh}\right) = Var\left(E\left[R_{sh}|\mathcal{F}\right] + \varepsilon\right) \tag{18}$$

$$= Var\left(E\left[R_{sh}|\mathcal{F}\right]\right) + Var\left(\varepsilon\right) + 2Cov\left(E\left[R_{sh}\right]|\mathcal{F}, \varepsilon\right) \tag{19}$$

where $\varepsilon = R_{sh} - E\left[R_{sh}|\mathcal{F}\right]$ is the SPAC shareholders' forecast error of the de-SPAC return. The left-hand-side captures the total cross-sectional variation in realized returns, while the first term on the right-hand-side of Equation 19 is the variation explained by SPAC investors' conjecture. The higher the ratio $Var\left(\varepsilon\right)/Var\left(R_{sh}\right)$, the more substantial the degree of information asymmetry.

Panel A of Table 4 reports the decomposition results. We normalize the total variance to 1 so that the decomposition shows the fraction of the total variation explained by different components. SPAC shareholders' forecast errors explain 54% of the total variation in the realized returns, while their conjecture, together with the covariance term, explains the remaining 46%. This decomposition suggests that SPAC shareholders often make significant mistakes in forecasting de-SPAC returns.

Next, we explore the sources of the forecast errors, which arise from two channels. First, since shareholders can only infer the deal fundamentals based on the observable deal terms, their forecast precision depends on how revealing those deal terms are regarding the actual deal fundamentals. If every combination of deal terms corresponds to a unique set of deal fundamentals, then not observing the latter will not impose a challenge for shareholders to correctly forecast the deal returns. In contrast, if a pooling equilibrium is prevalent, and deals with very different fundamentals yield similar terms, it is would be difficult for shareholders to distinguish strong deals from poor ones based on the announced deal terms alone. We refer to this as the error due to *fundamental information asymmetry*. Second, our estimation suggests that SPAC shareholders have bounded rationality as captured by the parameter $\sigma_e > 0$. They are unable to extract all the information embedded in the deal terms and on average make imperfect inferences based on the deal terms. We refer to this as the error due to bounded rationality.

To distinguish these two channels, we further decompose the variance of forecast errors as follows:

$$\begin{aligned} Var(\varepsilon) = {} & Var\left(R_{sh} - E^{PRE}\left[R_{sh}|\mathcal{F}\right]\right) + Var\left(E^{PRE}\left[R_{sh}|\mathcal{F}\right] - E\left[R_{sh}|\mathcal{F}\right]\right) \\ & + 2Cov\left(R_{sh} - E^{PRE}\left[R_{sh}|\mathcal{F}\right], E^{PRE}\left[R_{sh}|\mathcal{F}\right] - E\left[R_{sh}|\mathcal{F}\right]\right) \end{aligned} \tag{20}$$

where $E^{PRE}\left[R_{sh}|\mathcal{F}\right]$ is the forecast of de-SPAC return based on deal terms if SPAC shareholders have perfectly rational expectations regarding the sponsor's and target's policy function (i.e., if $\sigma_e \to 0$). The first term on the right-hand-side captures the fundamental information asymmetry channel: how informative the deal terms are in terms of revealing the deal fundamentals. The second term captures the bounded rationality channel, and the third term is the covariance between the two channels.

To implement and quantify this decomposition of forecast errors, we create a hypothetical SPAC investor in our model simulation. We assign $\sigma_e \to 0$ to this hypothetical investor but still impose on him the same constraints as all other investors in the model: first, he cannot observe the deal fundamentals (ℓ, z, u); second, he also faces latent demand shocks as he makes redemption decisions and thus Equation 16 describes his likelihood of redemption given his expectation of de-SPAC returns. This ensures that the hypothetical investor is comparable to other SPAC shareholders in all aspects except σ_e.

Panel B of Table 4 reports the decomposition of forecast errors described in Equation 20 using the hypothetical investor's conjectured return as $E^{PRE}[R_{sh}|\mathcal{F}]$. Both the fundamental information asymmetry and the bounded rationality channels appear to be significant, with the former accounting for more than 30% of the forecast errors, while the latter explains about 61%. Combined with the size of the total forecast errors, our estimate suggests that the fundamental information asymmetry results in about 16% of variation in cross-sectional de-SPAC return ($54\% \times 0.30 = 16\%$), while investors' bounded rationality adds another 32% ($54\% \times 0.61 = 32\%$).

We also illustrate the effect of the two channels on shareholders' inference of deal returns in Figure 8. The left panel shows the de-SPAC return conjectured by SPAC shareholders, while the right panel shows the return conjectured by our hypothetical investor with $\sigma_e \to 0$. The scattered points represent simulated deals, and the 45-degree dashed line corresponds to the correct forecasts where $\mathrm{E}[R_{sh}|\mathcal{F}] = R_{sh}$. In general, expected de-SPAC returns are positively correlated with the realized returns in both panels. The correlation is higher for the hypothetical investor who makes perfect use of the information available from the deal terms, but there is still substantial noise due to the pooling of deal terms. A given level of estimated (expected) de-SPAC return (i.e., fix a value on the x-axis) corresponds to a large range of possible realized returns (y-axis), even for an investor with perfect rationality. This, combined with the fact that our estimation reveals a sizable degree of bounded rationality for the average SPAC shareholder, leads to a substantial degree of variation in their returns from investing in SPACs.

7 Policy Experiments

Given the feverish pace of SPAC IPOs and business combinations of late, the SEC released a series of policy proposals on March 30, 2022, intended to improve the welfare of SPAC investors. Meanwhile, there are also numerous commentaries and suggestions regarding various aspects of SPACs that could potentially be regulated, and also expressing concern or support for proposed regulatory changes. We use our estimated model as a laboratory to evaluate the efficacy of several regulatory proposals widely discussed among academic researchers and industry practitioners. First, subjecting the sponsors' promote shares to progressively more stringent earnouts (Section 7.1). Second, reducing the number of warrants issued in SPAC IPOs (Section 7.2). Third, increasing the information transparency in SPAC deals, thereby improving the precision of investors' estimation of de-SPAC returns (Section 7.3).

7.1 Sponsor Earnouts

The primary source of frictions in our estimated SPAC model is the misaligned interests between SPAC sponsors and SPAC investors, particularly when the deal is poor. This misalignment is primarily driven by the sponsors' promote shares, since they become worthless in a liquidation, but can still be lucrative in a bad deal that completes. Thus, the sponsors' promote shares push them to close deals to the detriment of shareholders. In light of this, sponsor earnouts have been touted as an innovative way to align sponsor and shareholder interests, because they tie sponsor compensation to post de-SPAC share price.[20]

Specifically, an earnout requires that a SPAC's share price reaches a specified threshold before the sponsor receives a specified portion of his promote stake. If the de-SPAC share price does not reach the threshold, the corresponding promote shares are canceled. A typical threshold is set to be \$12.5 or \$15, or higher, which requires the share price to appreciate 25% or 50% (or more) post-merger relative to the IPO price before the sponsor's earnout shares are released.

In a recent study, Klausner and Ohlrogge (2022) document that earnouts as currently structured have a minimal impact on mitigating the agency costs in the standard SPAC structure. They use simulations to show that the value of earnouts is very close to the value of promote shares when their maturity is long and the volatility of post-merger stock prices is high, as is common. In contrast, we value the earnouts in our sample with binomial trees using the method of Cox, Ross, and Rubinstein (1979), and we similarly find that most earnouts have limited impact on sponsor compensation. For example, assuming an underlying annualized volatility of 60%, a 5-year earnout with a trigger

[20] In fact, earnouts are fairly standard fare in traditional M&A deals involving private targets, specifically for the purpose of overcoming asymmetric information and agency problems (Cadman et al., 2014).

price of \$12.50 is worth \$8.98 if the underlying promote share is worth \$10. A 3-year earnout only reduces that value slightly to \$8.30.

Klausner and Ohlrogge (2022) propose to improve the efficacy of earnouts by reducing their maturity. Since our model relies on the share price 3-month post de-SPAC to measure performance, our policy experiment considers the impact of 3-month earnouts. As a preliminary means of comparison, a binomial model with monthly time-steps (and 60% annualized volatility values a 3-month earnout with a trigger price of \$12.50 at \$3.00 relative to a \$10 promote share. In other words, these appear to have substantial bite.[21]

Our policy experiment using earnouts involves forcing sponsors to tie a certain fraction, χ, of their promote to earnouts (with a trigger price of \$12.50 and effectively T = 3 months). For instance, if $\chi = 0.4$, then the sponsor's compensation contains 0.1 share of earnouts ($0.1 = 0.25 \times 0.4$) and 0.15 promote shares. In solving the model, we still allow the sponsor to forfeit his promote shares as in the baseline model, but we assume that they do not alter their compensation tied to earnouts. In this policy experiment, we vary the value of χ and investigate how increasing the fraction of earnouts in sponsor compensation helps improve SPAC shareholders' welfare.

Panel A of Figure 9 shows the results. As χ increases, the average return to non-redeeming shareholders rises monotonically. Quantitatively, for every 10% increase in the fraction of compensation tied to earnouts, the average return to SPAC shareholders increases by 1.8 percentage points. As a result, tying sponsors' promote shares to an earnout indeed improves shareholders' welfare substantially. These findings are in line with the suggestions put forth in Klausner and Ohlrogge (2022), regarding the potential efficacy of using short-term earnouts.

If earnouts help mitigate the agency costs and better align the interest of the sponsor and shareholders, then we should expect the results to be stronger among SPACs that suffer from more severe agency problems. To examine the heterogeneous effects of earnouts, we contrast the average return to non-redeeming shareholders across SPACs with the top/bottom quintile agency costs. We track how the average returns to the

[21] In a preliminary ruling in the CCXX/MPLN case, the Judge (Vice Chacellor Will) insinuated that had CCXX's sponsor, Michael Klein, tied the entire promote stake to an earnout, as opposed to only about half, the Court would likely not have ruled that his interests were conflicted, implying that Will would have applied the Business Judgement Rule instead of the stricter Entire Fairness Standard. See Court of Chancery, re Multiplan Corp Stockholders Litigation, C.A. No. 2021-0300-LWW (Jan 3, 2022).

shareholders in these two groups of SPACs vary as the fraction of earnouts, χ, in the sponsor's compensation structure, changes. In Panel B of Figure 9, we confirm that as a larger fraction of sponsor compensation is tied to earnouts, the average returns to shareholders increase for both groups, but the increase is much more pronounced for SPACs facing more severe agency problems. Specifically, for every 10 percentage-point increase in χ, the average return to shareholders in SPACs with low agency costs improves by 0.7 percentage points while the average return in SPACs with high agency costs improves by 2.2 percentage points. This finding suggests that sponsor earnouts are effective devices in mitigating agency costs, thereby leveling the playing field for outside investors, in line with the SEC's objectives. The heterogeneous effects of earnouts shrink the gap between the returns to shareholders in the two groups. The red dotted line in Panel B of Figure 9 indicates that the gap is reduced from about 20% to 5% as we increase χ from 0% to 100%. The remaining gap is due to the fact that, even though sponsors no longer have an incentive to push through bad deals when all their compensation is tied to earnouts, sponsors with high agency costs still tend to allocate a larger fraction of the combined firm's value to targets in good deals. This is because they internalize shareholders' gains to a lesser extent, so they tend to overpay targets in the Nash bargaining process.

Overall, we find that sponsor earnouts, when implemented with short maturity, can dramatically reduce incentive conflicts between sponsor/target and shareholders, thereby substantially improving the welfare of SPAC shareholders.

7.2 Public warrants

Units issued in SPAC IPOs typically contain warrants. Warrants are like call options in that they can be exercised and converted to shares if the post de-SPAC stock price is above the strike price. However, unlike call options, when warrants are exercised, new shares that are worth more than the strike price are created and sold to the exercising party at the strike price, resulting in dilution. At some point after the SPAC IPO, the warrants and shares that comprise a unit begin to trade separately, and some studies show that, at the time of the redemption decision, SPAC shareholders are often not the warrant holders. Klausner et al. (2022) and Gahng et al. (2022) document that warrants are costly to non-redeeming shareholders, because they dilute the combined firm's value when exercised, transferring wealth from non-redeeming shareholders to warrant holders, and this problem is exacerbated when redemptions are high. Both the SEC and commentators propose reducing the number of warrants issued in units, in the hope of curtailing the dilution caused by the presence of SPAC warrants, and thereby retaining more value for non-redeeming shareholders.

Our baseline model includes warrants, and we use the empirical distribution of warrants in our estimation (the distribution of warrants in our sample is given in Figure 2). To implement a policy experiment related to warrant issuance, we assume that existing SPACs cut back their use of warrants issued in IPO by a fraction of ψ, in response to a regulatory change. For instance, if a SPAC issues 0.5 warrants per unit in the baseline model, then we assume it now issues $0.5(1-\psi)$ in this policy experiment. $\psi = 0$ nests the baseline case and $\psi = 1$ represents the case in which warrants are completely abandoned.

We examine how the returns to SPAC shareholders change as we gradually reduce the number of warrants by moving from $\psi = 0$ to $\psi = 1$. Panel A of Figure 10 depicts the trajectory. We observe that average returns to SPAC shareholders increase as warrants are reduced, but the improvement appears substantially smaller than that obtained from the policy experiment based on sponsor earnouts. In particular, we find that for every 10% reduction in the average number of warrants issued per SPAC unit, returns to non-redeeming shareholders increase by about 0.28%. This gain is only a small fraction of the 1.8% achieved through sponsor earnouts.

Should eliminating warrants help reduce agency costs, in the same way that the imposition of sponsor earnouts does? To answer this question, we contrast the returns to shareholders in SPACs with high/low agency costs, as we did above for the experiment using sponsor earnouts. Panel B of Figure 10 suggests that, reducing warrants indeed improves shareholder value for both high and low ℓ groups, but the gain does not seem to arise from curbing agency costs. In fact, the gap between the returns to shareholders in the high vs. low agency costs group actually widens rather than shrinks. In other words, eliminating warrants makes SPACs with low agency costs better, but it does not help SPACs with high agency costs as much. Intuitively, warrants are exercised only when the proposed deals are good and they become irrelevant when the deals perform poorly. Our analyses show that for SPAC investors, the primary source of the losses in welfare comes from staying with poorly-performing deals. In those deals, the warrants are more likely to remain under-water, and thus their existence has little impact on the sponsor's decision or shareholder welfare.

Overall, we find that warrants are not the main driving force of poor returns to SPAC shareholders in the current market. Even though cutting back on warrants could further improve the returns to SPAC shareholders with low agency costs, it has very limited power in curbing agency costs, or leveling the playing field for SPAC investors. The sponsor's incentive to push through bad deals is not mitigated by reducing warrant issuance.

7.3 Improving information transparency

Lastly, we examine the SEC's proposals regarding improving the information transparency of SPAC deals. Under the proposed rules, SPAC sponsors would be required to disclose any material conflicts of interest, provide a table spelling out dilution under various redemption scenarios, speak to the fairness of the proposed transaction, and spell out the particulars of their compensation, among other items. Since the motivation for these proposed changes is to make the disclosed deal characteristics more revealing of deal fundamentals, we estimate its efficacy by reducing SPAC investor's forecast errors.

Specifically, we consider an improvement of information transparency that is sufficient to neutralize the forecast errors due to the investors' bounded rationality. To do so, we compare the difference in the returns between an average investor and the hypothetical investor defined in Section 6.2 with $\sigma_e \to 0$. We find that the hypothetical investor earns, on-average, a 7.45 percentage-point higher return. Moreover, unlike the policy experiments above regarding earnouts and warrants that mainly influence the non-redeeming shareholders, the effect of this policy mainly arises from the shareholders' decisions on whether to redeem or not given the observable deal terms. Figure 11 illustrates a decomposition of this result by plotting the difference in the redemption rates between the hypothetical investor (δ_{PRE}) and the regular investor (δ_{REG}). It shows that for the hypothetical investor, the improvement of his return comes primarily from the ability to avoid more bad deals. This corresponds to the upper-left quadrant of Figure 11, where the hypothetical investor redeems more often when the realized deal returns are low.[22] It happens in about 40.7% of deals (i.e., the extensive margin), and the average gain from a higher redemption rate by the hypothetical investor in these bad deals amounts to 17.17 percentage points (i.e., the intensive margin). Similarly, the lower-right quadrant of Figure 11 represents cases in which the hypothetical investor is better at catching good deals (i.e., redeeming less when R_{sh} is high), which happens for 25.6% of the deals but with a smaller intensive margin (on average 2.91 percentage points higher return.)

Interestingly, improving information transparency does not always lead investors to make better decisions in every deal. The upper-right quadrant represents the good deals that the hypothetical investor fails to catch compared to regular investors (32.6% of the deals), and the lower-left quadrant represents the bad deals which the hypothetical investor falls into (1.1% of the deals). These are the two scenarios in which the hypothetical investor under-performs regular investors. This happens because both investors are subject to the same fundamental information asymmetry in the inference of deal quality, and forecast errors of the regular investors sometimes result in them being luckier and redeeming less (more) when the deals are good (bad). However, the gains/losses from these scenarios, or the intensive margins, are much smaller, visible from the fact that the dots in those regions are much closer to the $R_{sh} = 0$ line than the dots in the upper-left quadrant. Overall, we find that if the improvement of information transparency is sufficient to neutralize the investors' forecast errors due to bounded rationality, it will significantly improve the investors' return primarily through withdrawing more from bad deals.

8 Conclusion

The recent boom in SPACs has attracted considerable attention from both researchers and practitioners. The unique structure and business model of SPACs calls into question the specific incentives of SPAC sponsors and the associated welfare of their investors. In this paper, we quantitatively investigate these effects and the consequences of information

[22] Note that the redemption decisions of both investors are based on $\mathrm{E}[R_{sh}|\mathcal{F}]$, their expected return given the deal terms. Thus, the fact that the hypothetical investors redeem more often when the realized deal return R_{sh} is low reflects the fact that the hypothetical investors' inference is not subject to bounded rationality.

opaqueness faced by public investors. Our results suggest that agency costs among SPACs sponsors are pervasive and have a significant influence on deal outcomes: on average, there is a 19% difference in expected returns between deals in the lowest quintile of agency cost and those in the highest quintile. These agency costs combined with the opaque information in the SPAC market result in the average SPAC investor making sizable forecast errors when inferring the underlying deal quality.

Our study contributes to the ongoing debate over the possible regulation of the SPAC market. The SEC's recently released proposals regarding the SPAC market have particularly highlighted the principles of "providing investors with additional information regarding a proposed de-SPAC transaction" and "addressing concerns regarding potential conflicts of interest and misaligned incentives." Meanwhile, these proposals have been met with a mixed reception from the financial industry, with some practitioners warning that these regulations would "kill the industry" by creating "too much liability for parties involved in SPAC deals, and, as such, goes further than rules for traditional IPOs and M&A."[23] Our results shed light on this policy debate by quantifying the incentive conflicts between SPAC sponsors and SPAC shareholders and the potential welfare impact of asymmetric information. Our policy experiments show that tying the sponsor promote to earnouts and improving the information transparency of the SPAC market can potentially lead to significant improvements in shareholder welfare, while cutting back warrant issuance in SPAC IPOs is likely to be benign.

To maintain focus, we prioritize the central role played by SPAC sponsors and minimize the decisions of SPAC targets regarding their willingness to accept the terms proposed. Interesting questions thus remain such as the trade-off SPAC targets face when they choose to sell themselves to a SPAC over a traditional IPO, or over staying private. These and related questions are left for future research.

[23] U.S. financial firms push back on SEC bid to rein-in blank check company deals. *Reuters*, June 2022.

Figures and Tables

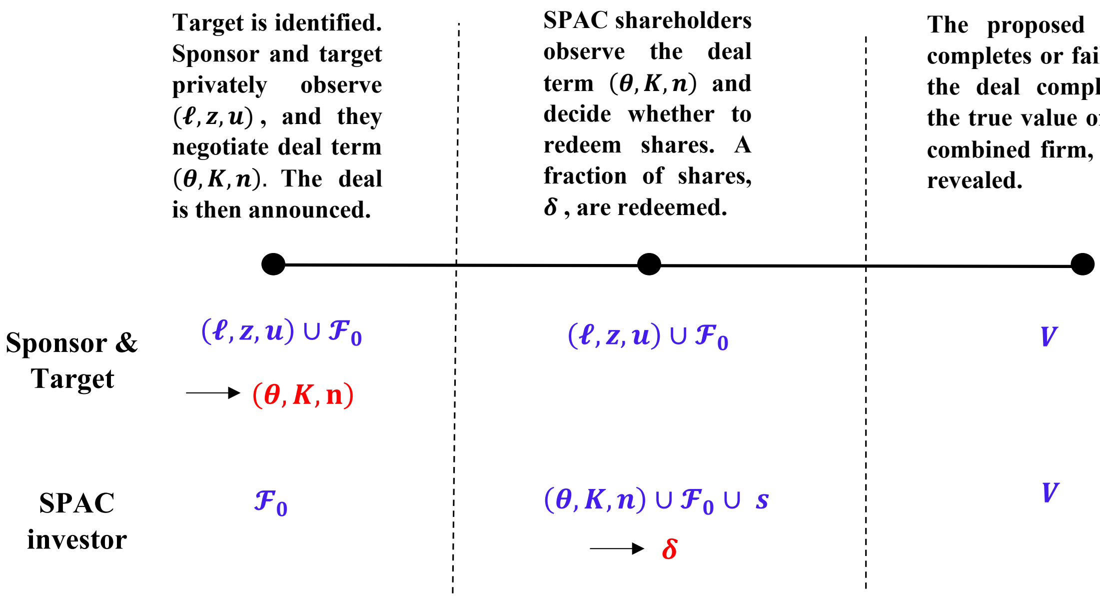


Figure 1. Model timeline.

This figure describes the timeline of the model. Variables in blue denote the information set of different agents, and variables in red denote their corresponding actions. The model contains three stages. In the first stage, the sponsor identifies a potential target firm and negotiate the deal terms. They observe the deal fundamentals including the sponsor's agency cost (ℓ), value creation (z), and the target's reservation value as a private entity (u). Anticipating the SPAC shareholders' redemption decision δ in the next stage, they choose the compensation accrued to the sponsor θ, the shares offered to the target n, and any additional capital to be raised externally K. In the second stage, the SPAC shareholders observe the deal terms (θ, K, n) and a possible signal regarding the deal quality s, and they choose the redemption rate δ. In the last stage, the true value of the combined firm V is revealed if the deal completes.

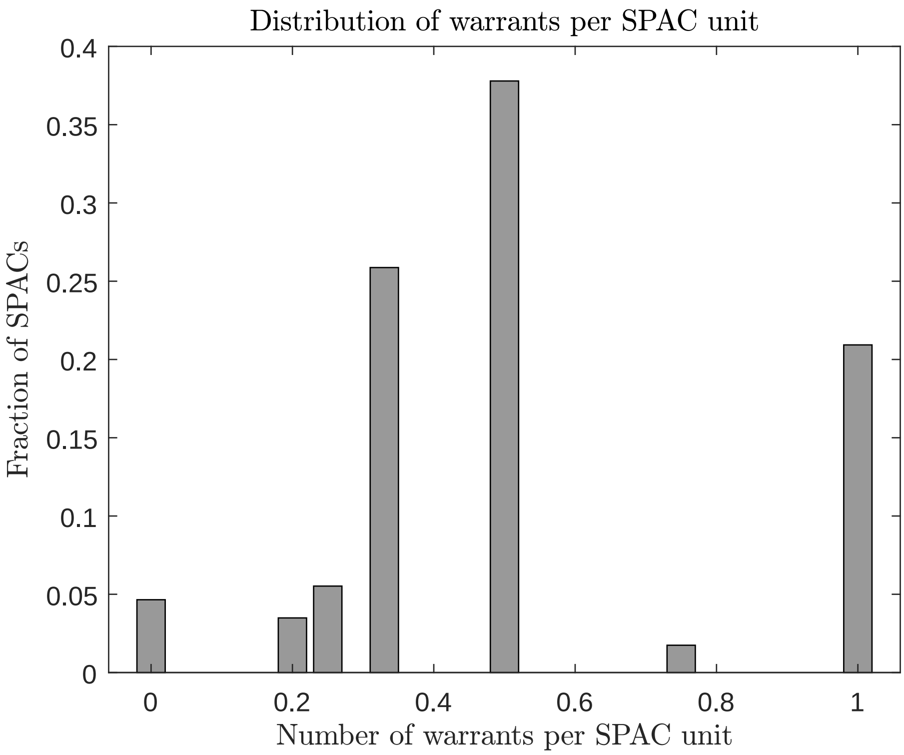


Figure 2. Distribution of warrants per SPAC unit.

This figure shows the distribution of SPACs that issue different numbers of warrants in their IPO units. Each IPO unit is composed of one share and w warrant and the common choice of w is 0, $\frac{1}{5}$, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, $\frac{3}{4}$ and 1. x-axis represents w and y-axis represents the fraction of SPACs that issue w warrants in each of their IPO unit.

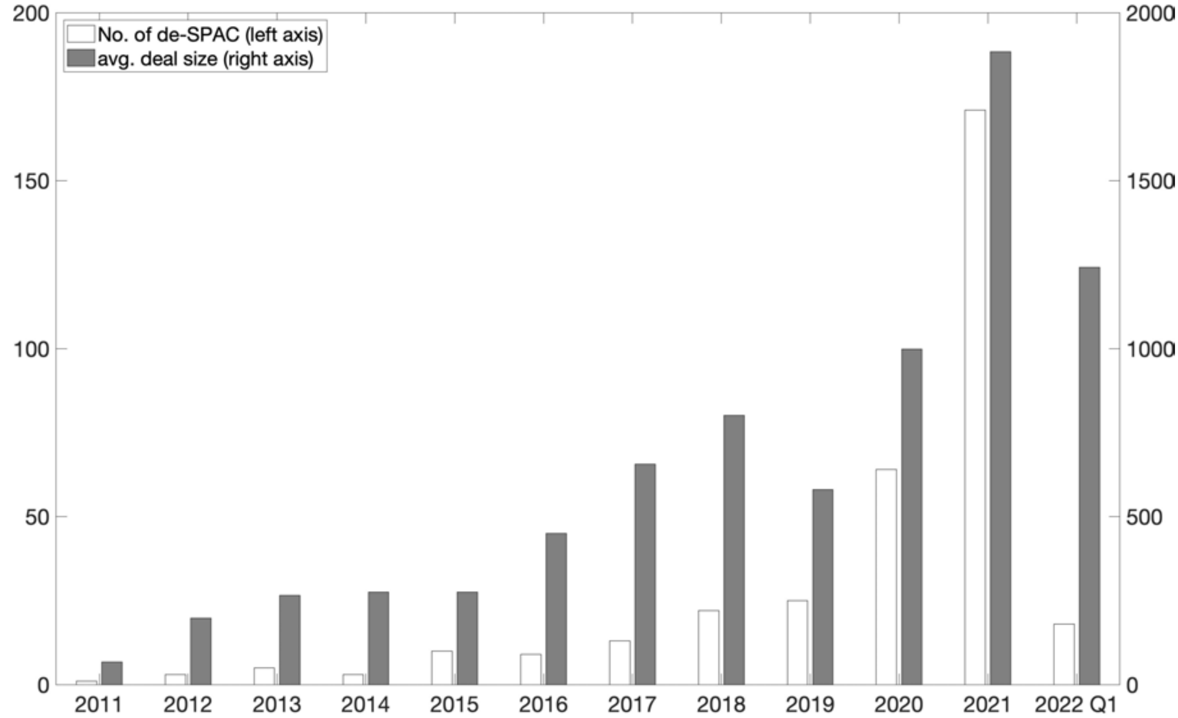


Figure 3. SPAC completions and average deal size by year

This figure shows the number of completed business combinations (white bars) and their average sizes (gray bars) by year in our sample. Note that for 2022, only the data of the first quarter are included. The left axis represents the number of completed de-SPAC, while the right axis represents the average size per deal, in millions of dollars.

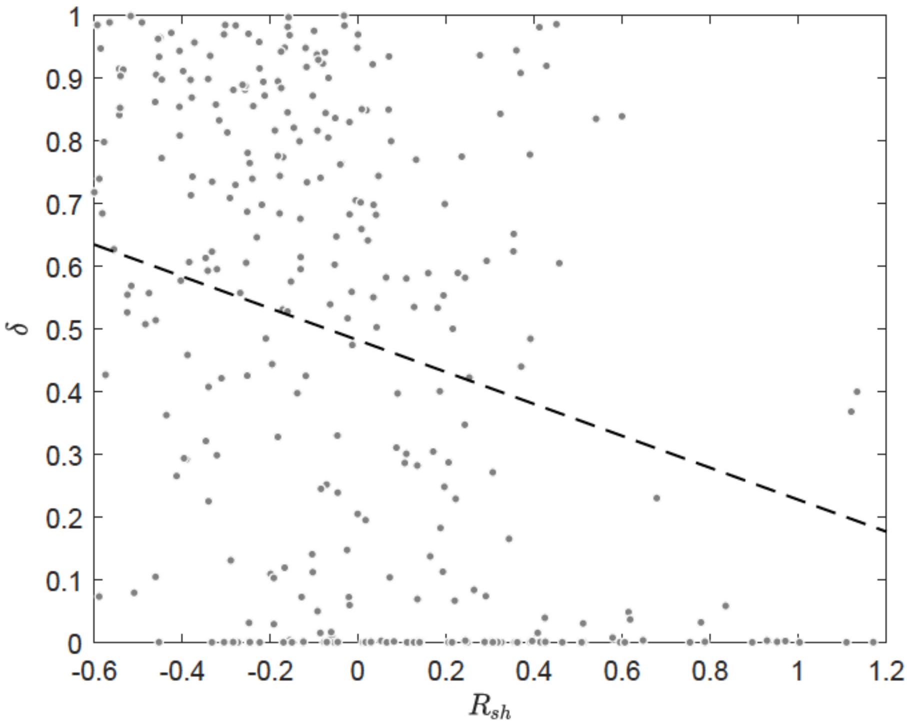


Figure 4. Redemption rate and returns to SPAC shareholders

This figure shows the relation between the aggregate redemption rate and returns to non-redeeming shareholders. Return to non-redeeming shareholders is the 3-month post de-SPAC risk-adjusted return calculated based on Equation (17). The scattered points represent individual deals and the dashed line depicts the best fit of a linear relation between redemption and returns. There exists a significant, negative association between the redemption rate and return to non-redeeming shareholders in the data.

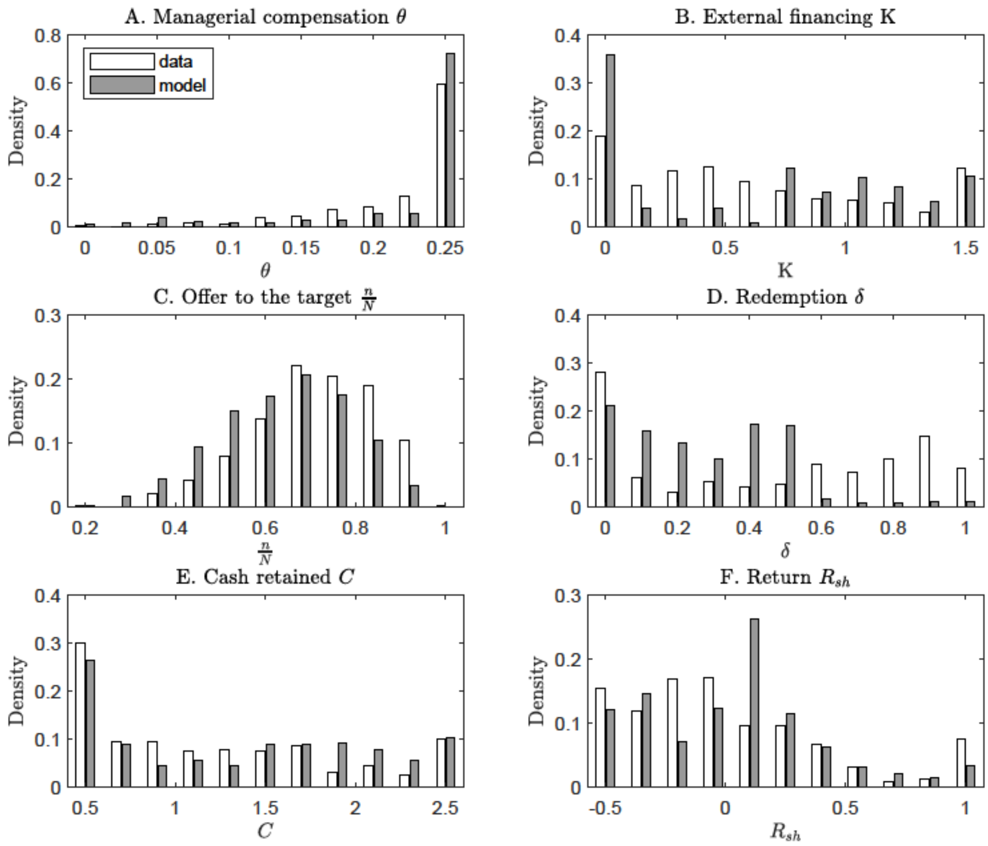


Figure 5. Model fit on variable distributions

This figure illustrates the model fit on the distribution of observable variables. We compare the empirical distribution of a variable (plotted in white bars) with its model-implied distribution (plotted in gray bars). Panel A compares the distribution of the sponsor's compensation θ, panel B compares the external capital raised K, panel C compares the offers made to the target, expressed as a fraction of ownership in the combined firm $\frac{n}{N}$, panel D compares the redemption rate δ, panel E compares the cash retained in the firm C, and panel F compares the return to SPAC shareholders R_{sh}.

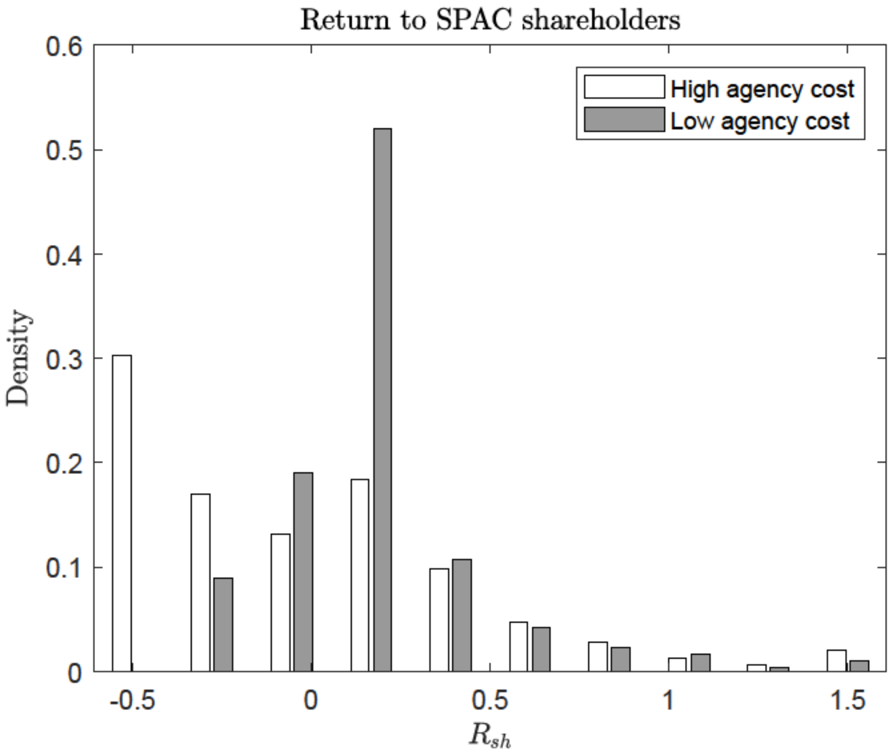


Figure 6. Returns to SPAC shareholders: low vs. high agency cost

This figure compares the distribution of returns to SPAC shareholders, R_{sh}, for deals with high agency cost (top quintile of ℓ, white bars) and low agency cost (bottom quintile of ℓ, gray bars). Both distributions are plotted based on simulated deals using the parameter estimates in Table 3.

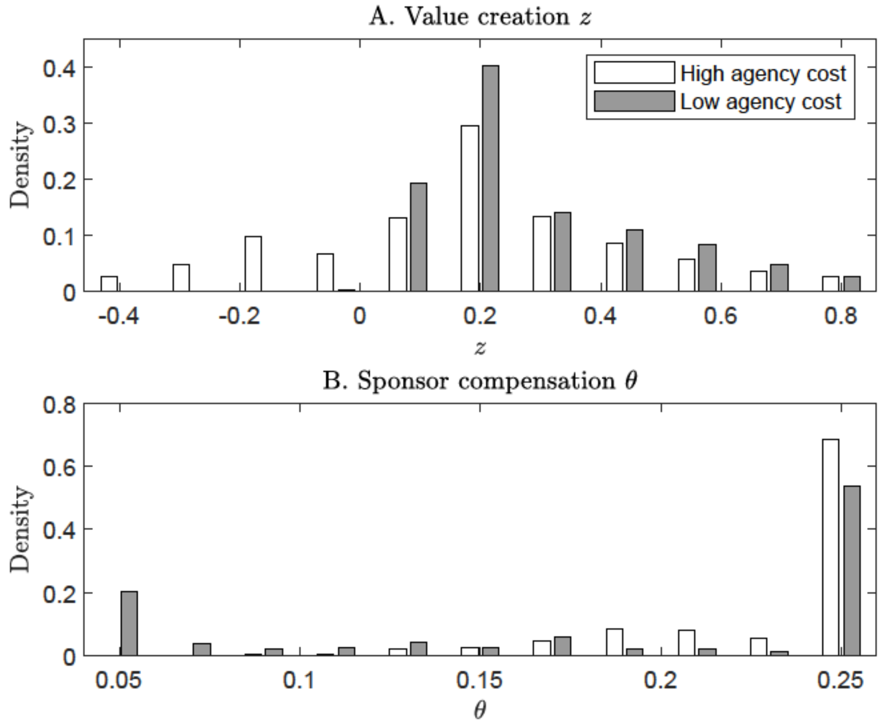


Figure 7. Deal quality and sponsor compensation: low vs. high agency cost

This figure compares the distribution of deal quality z (Panel A) and the sponsor's compensation θ (Panel B) for deals with high agency cost (top quintile of ℓ, white bars) and low agency cost (bottom quintile of ℓ, gray bars). Both distributions are plotted based on simulated deals using the parameter estimates in Table 3.

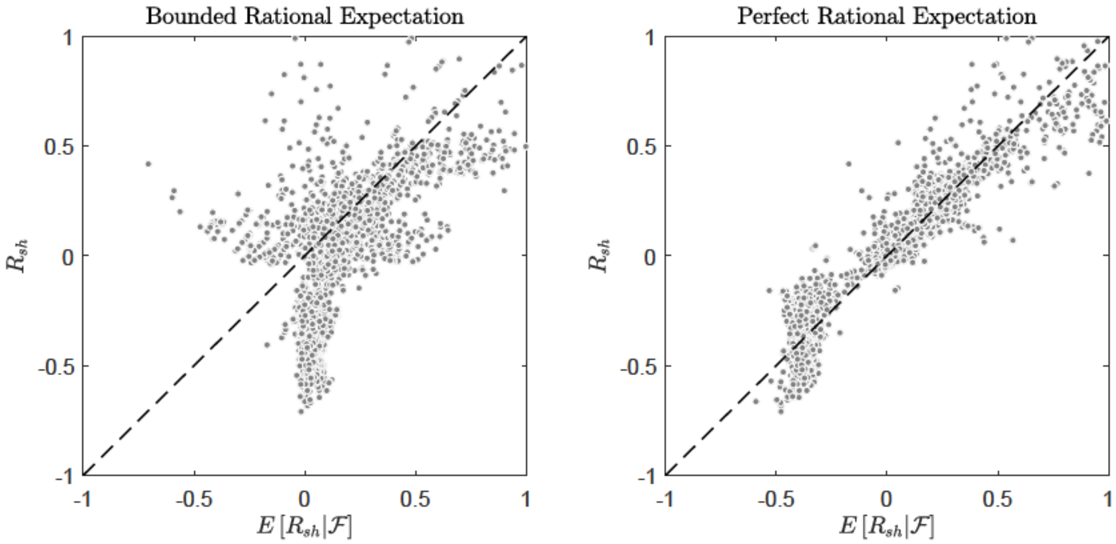


Figure 8. Forecast of deal returns: bounded vs. perfect rational expectation

This figure compares the forecast of returns to SPAC shareholders by a regular SPAC investor with bounded rationality as in the baseline model (left panel) and a hypothetical investor with perfect expectation (right panel). The x-axis represents the expected return of the deal perceived by the investors, $E[R_{sh}|\mathcal{F}]$, and the y-axis represents the true return to shareholders in a given deal, R_{sh}. The dashed line (45-degree line) represents the accurate forecast. We simulate the model and plot the simulation results in scattered points. Dots closer to the 45-degree line represent better forecasts.

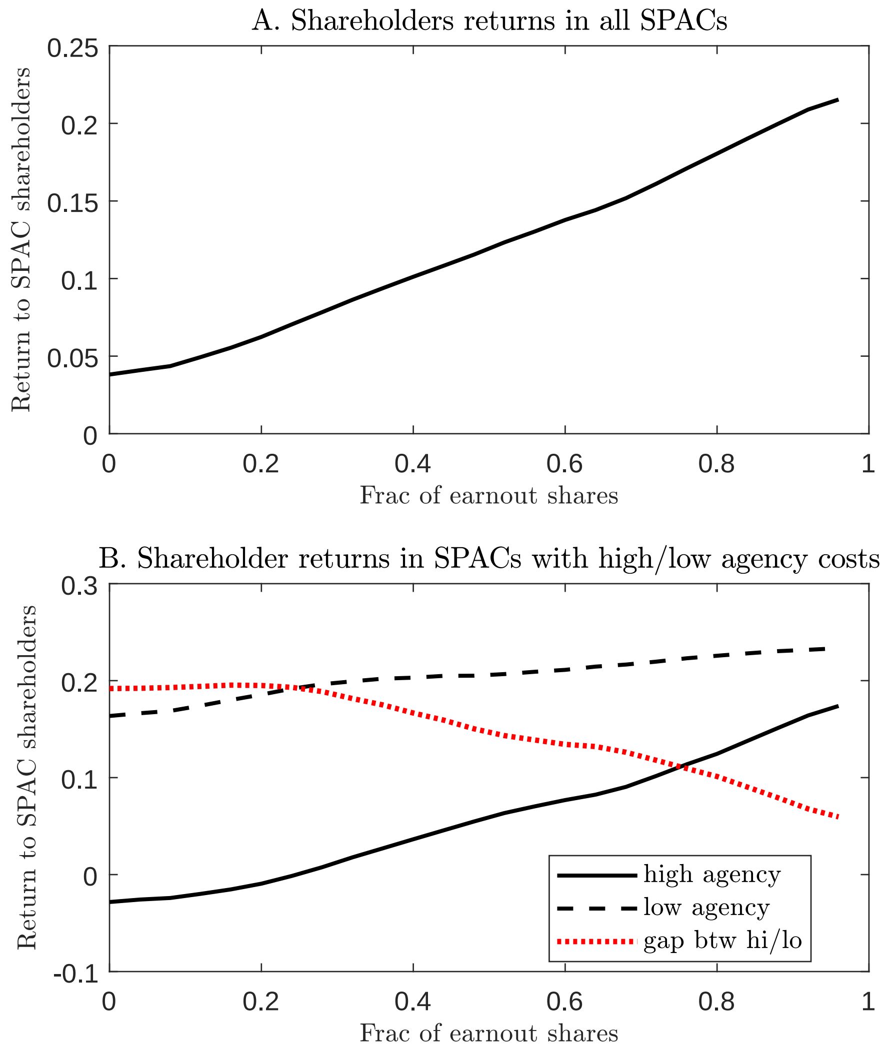


Figure 9. Policy experiment: sponsor earnouts

This figure illustrates the effects of a policy experiment that ties a certain fraction of sponsor compensation to earnouts. x-axis represents the fraction of sponsor compensation tied to earnouts, and y-axis is the average return to non-redeeming SPAC shareholders. Panel A shows the effects on the full sample of simulated SPACs, and Panel B shows the effects on the simulated SPACs with high agency cost (top quintile of ℓ, solid line) and low agency cost (bottom quintile of ℓ, dashed line) as well as the gap between them (red dotted line).

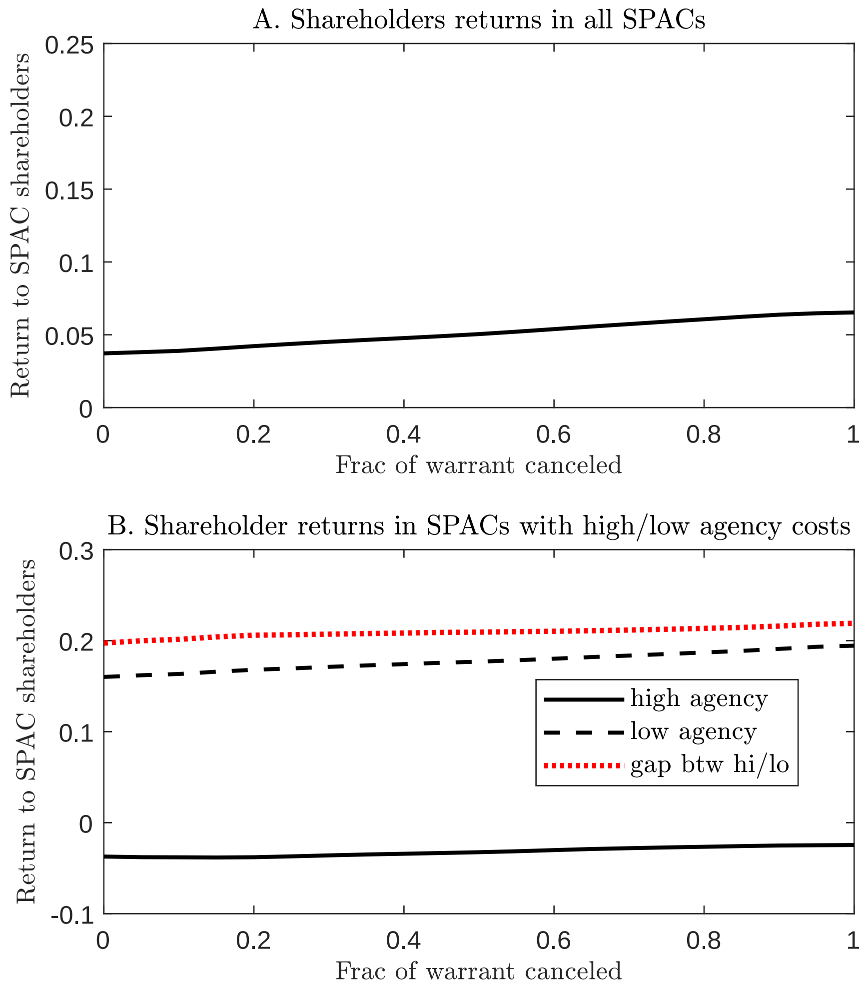
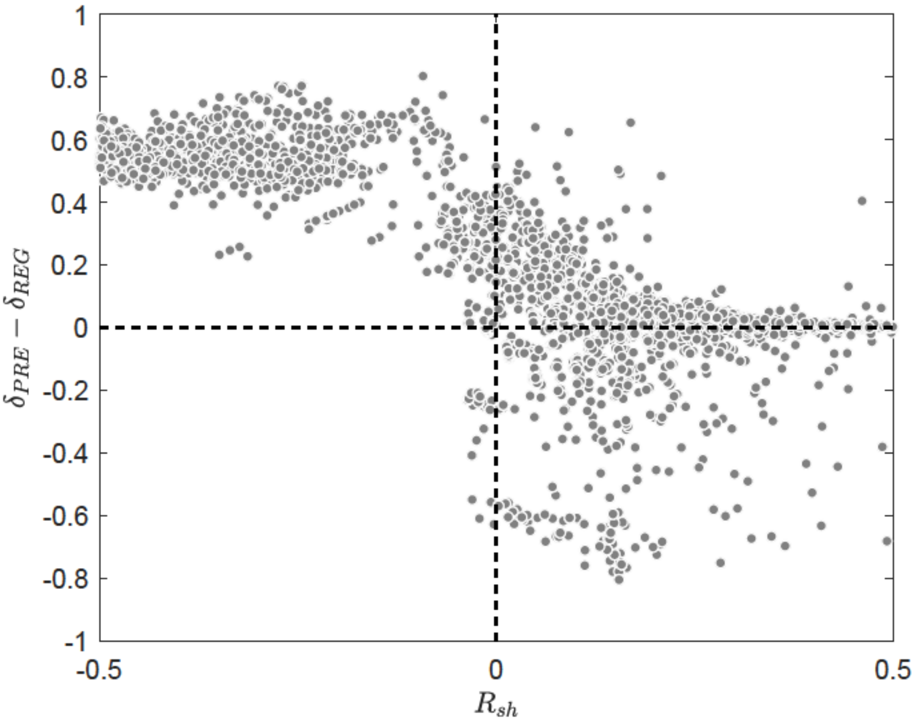


Figure 10. Policy experiment: public warrants

This figure illustrates the effects of a policy experiment that cuts back a certain fraction of public warrants issued in SPAC IPO. x-axis represents the fraction of warrants reduced in the policy experiment, and y-axis is the average return to non-redeeming SPAC shareholders. Panel A shows the effects on the full sample of simulated SPACs, and Panel B shows the effects on the simulated SPACs with high agency cost (top quintile of ℓ, solid line) and low agency cost (bottom quintile of ℓ, dashed line) as well as the gap between them (red dotted line).



Gains from increasing information transparency

	Total	Extensive Margin	Intensive Margin
Avoid bad deals	7.00%	0.407	17.17%
Catch good deals	0.75%	0.256	2.91%
Miss good deals	-0.30%	0.326	-0.91%
Fall in bad deals	-0.004%	0.011	-0.35%
Return gap (total)	7.45%		

Figure 11. Policy experiment: improving information transparency

This figure shows the relation between the ex-post deal performance and the difference in redemption likelihood if the proposed regulatory policies improve the transparency of the market sufficiently to the degree that neutralizes the forecast errors resulting from the investors' bounded rationality. We plot the ex-post deal performance on x-axis and the difference in redemption likelihood between the two investors on y-axis. The figure is divided into four quadrants by the two dashed lines. The panel below shows the improvement if the forecast errors from bounded rationality are neutralized. Each line corresponds to one of the four quadrants of the figure above. Specifically, "avoiding bad deals" corresponds to the upper-left quadrant; "catching good deals" corresponds to the lower-right quadrant;"missing good deals" corresponds to the upper-right quadrant; and "fall in bad deals corresponds to the lower-left quadrant.

Table 1. Summary Statistics

Panel A reports summary statistics for SPAC deals. SPAC IPO proceeds refer to the amount raised by SPACs in their IPOs, taking into account any exercise of the over-allotment option; External capital refers to any funds raised via unregistered equity sales and used to supplement the SPAC's cash trust; Total consideration refers to the dollar value of consideration (sum of cash and shares) paid to target owners. Reported values are in millions of dollars for these three variables. Sponsor earnouts refer to portions of the sponsor's promote whose vesting is tied to performance metrics; Target earnouts are similar to sponsor earnouts, but are part of the consideration offered to the target owners; Total redemption refers to the total number of shares redeemed by SPAC shareholders up to and including at the final up or down vote on the proposed business combination; Promote shares forfeited refers to the number of the sponsor's promote shares that he has offered to forfeit without compensation; Private Placement warrants forfeited are analogously defined for private placement warrants purchased by the sponsor concurrently with the SPAC's IPO. Reported values are in millions of shares for these five variables. Performance is the 3-month post de-SPAC risk-adjusted return calculated based on Equation (17). Panel B reports a subset of the same characteristics of SPACs as in Panel A, but stated in terms relative to IPO shares sold.

Panel A. SPAC Deal Characteristics

	Mean	Median	75th %ile	25th %ile	Std Dev	Non-Zero Avg.	Non-Zero Obs
IPO Proceeds	278	238	345	144	214	n/a	n/a
External capital (FPA, PIPE, Backstop)	245	125	290	26.5	570.00	296	284
Total Consideration	1313.0	797.0	1427.5	328.0	2443.0	n/a	n/a
Sponsor earnouts	0.673	0	0.500	0.000	2.495	2.572	90
Target earnouts	3.879	0	6.000	0	12.886	10.590	126
Total Redemptions	7.282	7.854	18.781	0.383	12.546	n/a	n/a
Promote Shares Forfeited	0.661	0	0.750	0	1.295	1.776	128
Priv Plac Warrants Forfeited	0.436	0	0	0	1.831	3.946	38
Performance	0.051	-0.072	0.242	-0.292	0.591	n/a	n/a

Panel B. Relative to IPO Cash/Shares

	Mean	Median	75th %ile	25th %ile	Std Dev
External capital (FPA, PIPE, Backstop)	0.727	0.510	0.987	0.196	0.994
Redemption (% of IPO Shares)	0.468	0.535	0.837	0.016	0.373
Promote Stake Retained (0.25 is Max)	0.220	0.250	0.250	0.208	0.046
Offer to Target (% of Total Shares)	0.704	0.716	0.806	0.631	0.136

Table 2. Model fit: empirical moments vs. model-implied moments

This table reports the model fit. The first column lists the 13 moments we target to match in the simulated method of moments (SMM), the second column provides the definition for each moment, and the third and fourth columns show the empirical value of the moments and the model-implied counterparts. K is the external capital raised by a SPAC firm via PIPE or FPA after SPAC IPO; δ is the aggregate redemption rate, measured as the amount of IPO shares redeemed scaled by the total number of IPO shares; θ is the sponsor's promote stake normalized by the number of IPO shares; C is the total cash delivered to the target by the SPAC in the de-SPAC, including the non-redeemed shares $1-\delta$ and the cash raised externally K; $\frac{n}{N}$ is the offer made to the target, expressed as the ownership in the combined firm post deal completion; R_{sh} is the 3-month post de-SPAC risk-adjusted return calculated based on Equation (17).

Moment	Definition	Empirical value	Simulated value
Mean(K)	Avg. external capital raised	0.727	0.631
Std(K)	Stdev. of external capital raised across deals	0.994	0.562
Frac($0.1 < \delta < 0.9$)	The fraction of deals with redemption ratio between 10% and 90%	0.529	0.685
RegCoef(δ, R_{sh})	Regression coefficient of regressing delta on returns to SPAC shareholders	-0.272	-0.293
Mean(θ)	Avg. compensation to sponsor	0.220	0.220
Std(θ)	Stdev. of compensation to sponsor across deals	0.046	0.063
Mean($\frac{n}{N}$)	Avg. fraction of the combined firm's shares offered to the target	0.704	0.637
Std($\frac{n}{N}$)	Stdev. of the fraction of the combined firm's shares offered to the target	0.136	0.146
Mean(R_{sh})	Avg. return to non-redeeming SPAC shareholders	0.051	0.042
Std(R_{sh})	Stdev. of returns to non-redeeming SPAC shareholders	0.591	0.423
Frac($C < 0.5$)	The fraction of SPACs that deliver less than 50% of cash raised in IPO to targets	0.299	0.263
Frac($1.3 < C < 1.7$)	The fraction of SPACs that deliver 130% to 150% of cash raised in IPO to targets	0.076	0.090
Frac($C > 2.3$)	The fraction of SPACs that deliver more than 230% of cash raised in IPO to targets	0.102	0.100

Table 3. Parameter value estimation

This table reports the estimated model parameters. We search the value of parameters to minimize the distance between the empirical moments and the model-implied moments in SMM. The first column of the table lists the notation of parameters, the second column provides the definition of the parameters, and the third column reports the estimated parameter values.

Parameter	Definition	Value
μ_z	Avg. of deal quality $\ln(1+z)$	0.013
σ_z	Stdev. of deal quality across deals $ln(1+z)$	0.28
μ_u	Avg. of $\ln(u)$, u is the target value as a private entity	0.85
σ_u	Stdev. of $\ln(u)$, u is the target value as a private entity	1.21
α	Parameter of Beta distribution $Beta(\alpha, \beta)$ for sponsor agency cost ℓ	1.00
β	Parameter of Beta distribution $Beta(\alpha, \beta)$ for sponsor agency cost ℓ	1.00
ϕ_1	The linear component of variable cost of raising external capital	0.004
ϕ_2	The quadratic (convex) component of variable cost of raising external capital	0.098
σ_δ	Heterogeneous preference of SPAC shareholders in redemption decision	0.095
σ_e	SPAC shareholders' bounded rationality regarding sponsors' policy	0.156
η	The precision of additional signal SPAC shareholders receive	0
λ	Constant term in deal completion rate $q(C) = \frac{1}{1+e^{-\gamma(C-\lambda)}}$	0.15
γ	Slope term in deal completion rate $q(C) = \frac{1}{1+e^{-\gamma(C-\lambda)}}$	1.25

Table 4. The effect of information asymmetry

This table reports our estimate of the magnitude of information asymmetry between SPAC shareholders and the sponsor as well as the effect of information asymmetry on SPAC shareholders' returns. Panel A decomposes the total variance of the cross-sectional deal return into the variance of the expected return and the variance of the forecast errors resulting from information asymmetry. Panel B attributes the forecast errors to two sources: forecast errors resulted from the pooling equilibrium in which deal value is not fully revealed even when investors have perfect rational expectations, and forecast errors resulted from the investors' bounded rationality.

Panel A. Variance decomposition of deal value	
$Var(R_{sh})$	1
$Var(\epsilon)$	0.54
$Var(E[R_{sh}\|F]) + 2Cov(E[R_{sh}\|F], \epsilon)$	0.46
Panel B. Variance decomposition of forecast errors	
$Var(R_{sh} - E[R_{sh}\|F])$	1
$Var(R_{sh} - E^{PRE}[R_{sh}\|F])$	0.303
$Var(E^{PRE}[R_{sh}\|F] - E[R_{sh}\|F])$	0.608
$2Cov(R_{sh} - E^{PRE}[R_{sh}\|F], E^{PRE}[R_{sh}\|F] - E[R_{sh}\|F])$	0.089

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Online Appendix

A Numerical algorithm

To solve the model numerically, we first discretize the state variables (ℓ, z, u) into grids of size N_ℓ, N_z, and N_u, respectively. We then discretize the policy functions (θ, K, n) and δ into grids of size N_θ, N_K, N_n and N_δ, respectively.

Since the shareholders' redemption rate δ is a function of the deal terms (θ, K, n) in equilibrium, we initialize its value on each grid of (θ, K, n) as:

$$\delta = \delta^{(0)}(\theta, K, n)$$

where $\delta^{(0)}(\cdot)$ is our initial guess of the redemption function $\delta(\theta, K, n)$. We then follow the steps below in each iteration $g \geq 1$:

1. Given the redemption function obtained in iteration $g-1$, $\delta^{(g-1)}(\theta, K, n)$, for each grid on the state variable triplet (ℓ, z, u), we search for the corresponding optimal deal terms, (θ, K, n), on the grids that solve the sponsor's and target's value maximization problem in Equation 9;

2. The above step produces the optimal deal terms in the g-th iteration:

$$\theta = \theta^{(g)}(\ell, z, u)$$
$$K = K^{(g)}(\ell, z, u)$$
$$n = n^{(g)}(\ell, z, u)$$

   Using the updated deal terms $(\theta^{(g)}, K^{(g)}, n^{(g)})$, we solve the shareholders' optimal redemption decision, as shown in Equations 12 and 16.

3. The above step produces the solution to the redemption rate in the g-th iteration:

$$\delta = \delta^{(g)}(\theta, K, n)$$

4. We compute the distance between the deal terms in the $(g-1)$-th iteration and the g-th iteration and the distance between the redemption rate in the two iterations.

5. We repeat steps 1 to 4 above until the distance of policy functions between the last two iterations falls below a predetermined threshold.

The above numerical algorithm solves the model for a given set of model parameters. Once the model is solved, we use the model to simulate a cross-section of SPACs and the associated mergers. Specifically, to simulate a SPAC and its proposed merger, we draw a realization of its state variable triplet (ℓ, z, u) from the joint distribution $f(\ell, z, u)$. Then we obtain the optimal deal terms that the sponsor and target will choose in the deal based on the optimal deal terms (θ^*, K^*, n^*) we solved in the model. We can also obtain the redemption rate by the SPAC shareholders, δ^*. Based on this set of information, we are able to compute the characteristics and outcomes of this deal.

B Data and Sample

B.1 Variable construction

We provide various cross-sectional data on our sample of SPACs/de-SPACs. These values are presented in Table 2, with raw values presented in Panel A and scaled values presented in Panel B.

IPO Proceeds is fairly self-explanatory, representing the total dollar value of proceeds raised in the SPAC IPO (in millions of $s), and also represents the value of the SPAC's cash trust if it is fully funded, which essentially they all are. This is the sum of the sought-after proceeds listed in the SPAC's IPO prospectus (Form 424B4), and any additional shares sold via the over-allotment (Green Shoe) option.[24] Sponsor earnouts are the number of sponsor promote shares tied to earnout provisions (in millions of shares), while Target earnout shares are similarly defined for the number of contingent shares given as a portion of the merger consideration paid to the target owners.

In terms of performance metrics, our focus is on the investor's redemption decision, wherein he/she has the choice to exchange their shares for approximately $10 each, or stick with the SPAC shares, in the hope of increasing the payoff. For this reason, we compare the price of the de-SPACed firm 3 months post business combination with the $10 that investors could have had had he redeemed his shares. Call this the return relative to redemption. We then compute the risk-adjusted de-SPAC return by subtracting the return from iShares Russell 2000 Growth ETF (IWO) during the same period. These are straight returns (not annualized).

External capital raised, or Private Placement, is the amount raised via PIPE, FPA, or Backstop agreement, in millions of dollars, while total redemptions are the total number of shares redeemed by SPAC IPO investors (in millions). Promote Shares Forfeited is the number of shares of the sponsor's promote stake that were voluntarily forfeited by the sponsor to push the deal through (in millions), while Private Placement Warrants Forfeited represent the number of private placement warrants that the sponsor offered to forfeit in order to enable the completion of a deal (in millions of warrants). And finally, the total consideration is the total dollar value of consideration paid to the target firm's owners in the business combination (in millions of $).

Panel B shows statistics on a subset of our cross-sectional variables, scaled by IPO shares or promote stake. Private Placement is the size of the PIPE or similar as a percentage of IPO shares sold. Redemption represents the fraction of IPO shares redeemed by IPO investors, Shares Granted and Total Shares are similarly defined for shares given to the target owners in consideration, and total shares outstanding. Finally, Promote Stake Retained gives a reading on the fraction of the promote retained by the sponsor, where IPO shares are redefined in our model as 1, and the baseline promote is then 0.25 shares.

B.2 Method of payment

We need to make one more adjustment to our variable definitions because our model assumes that all SPAC deals use strictly shares as consideration paid to the target shareholders. However, in reality, some deals in our sample involve some cash consideration.

[24]The SPAC promote is typically constructed under the assumption that the Green Shoe option is exercised. In the event this option is not exercised, the sponsor will forgo the requisite number of shares

We make the following adjustment to accommodate cash consideration. We divide the cash consideration by the price at the end of the performance period (3 months in our base case), to get a cash-equivalent number of shares. This allows us to convert all cash consideration to shares, yet leave the returns of all parties unaffected by the adjustment. We also examine the subset of deals that are essentially all cash and get qualitatively similar results.

To provide some context, 38.8% of deals that we study involve cash, meaning that nearly 62% of SPAC business combinations involve only shares. Focusing on the 38.8% of business combinations that involve some cash, just 3 deals are done with 100% cash, and only 33 deals (less than 10% of our sample) are majority financed with cash. Finally, only 27.9% of deals utilize more than 10% cash, and only 22% of deals utilize more than 20% cash.

B.3 Sponsor compensation

We gather information on SPAC sponsor compensation from the Super 8-K that is typically filed a few days after the closing of the proposed business combination. SPACs that are foreign-domiciled (typically in the Caribbeans) file Form 20-F in lieu of a Super 8-K.

In nearly every SPAC, the sponsor's main source of compensation is the sponsor's *promote shares*. The sponsor's promote is designed so that he/she holds 20% of the sum of IPO shares and promote shares, which means the sponsor's promote is defined as 25% of the IPO shares. The sponsor also purchases securities (usually warrants, but occasionally SPAC units in lieu of warrants) in a private placement coinciding with the SPAC IPO.

Sponsors understand that they can make any proposed deal more palatable to the other parties in the deal (PIPE investors, IPO investors, and target shareholders) if they forfeit, or make contingent, a portion of their compensation. Any such arrangements are typically reported in the Super 8-K and/or an attachment to the Super 8-K, and they are often also reported in the investor presentation that the SPAC/target put together to try to sell the deal to investors.

Sponsors can also potentially improve the economics of a transaction for the other parties by agreeing to tie a portion of their promote shares to the performance of the de-SPACed firm in what is known as an earnout. Earnouts are also typically disclosed in the Super 8-K and/or the investor presentation. Figure B.12 shows a snippet from the Super 8-K describing the business combination between Switchback Energy Acquisition Corp (the SPAC) and Chargepoint Holdings (the target company in the EV charging industry):

This information is also sometimes available in an attachment to the Super 8-K, especially the Unaudited Condensed Pro-Forma Information, as shown in Figure B.13.

Earnouts In our sample, 88 of our SPACs tie significant portions of the Sponsor promote to performance targets, utilizing what are known as "earnouts" (or sometimes written earn-outs, hereafter, EOs). This is approximately one-quarter of the sample of SPACs. Among these 88 SPACs, the average sponsor ties about 40% of their promote stake to an EO.

By agreeing to tie a portion of their compensation to performance targets (usually, but not necessarily, a price target), clearly, the sponsor is giving up something, the question is how much? In this appendix, we describe our implementation of the binomial model of

From the Super 8-K filed by Switchback Energy Acquisition Corp/Chargepoint Holdings

Filed on March 1, 2021

In addition, pursuant to a letter agreement (the "Founders Stock Letter") entered into by the holders of the Founder Shares (the "initial stockholders") and the Company in connection with the execution of the Business Combination Agreement, immediately prior to the Closing, the initial stockholders (i) **surrendered to the Company, for no consideration and as a capital contribution to the Company, 984,706 Founder Shares held by them (on a pro rata basis), whereupon such shares were immediately cancelled**, and (ii) **subjected 900,000 Founder Shares (including Common Stock issued in exchange therefor in the Merger) held by them to potential forfeiture in accordance with the terms of the Founders Stock Letter.** Upon the Closing, all outstanding Founder Shares converted into Common Stock on a one-for-one basis and the Founder Shares ceased to exist.

Forfeited shares highlighted in **yellow**, earnout shares in **green**

Figure B.12. Super 8-K

This figure illustrates an example of a source where we identify the sponsor's compensation using Super 8-K. Forfeited promote shares are highlighted in yellow and earnout shares are highlighted in green.

From the Unaudited Condensed Pro-Forma Information attached to the Super 8-K

The following summarizes the New ChargePoint Common Stock issued and outstanding immediately after the Business Combination:

	Pro Forma Combined (Shares)	%
Switchback Class A stockholders	31,378,754	11.3
Switchback Class B stockholders(1)	6,868,235	2.5
Former ChargePoint stockholders(2)(3)	217,021,368	78.1
PIPE Financing	22,500,000	8.1
Total	**277,768,357**	100.0

(1) Amount excludes the **984,706 Founder Shares surrendered to Switchback** and **includes 900,000 shares of New ChargePoint Common Stock subject to forfeiture until the Founder Earn Back Triggering Event has occurred.**

Forfeited shares highlighted in **yellow**, earnout shares in **green**

Figure B.13. Super 8-K

This figure illustrates an example of a source where we identify the sponsor's compensation using the unaudited condensed Pro-Forma information attached to the Super 8-K. Forfeited promote shares are highlighted in yellow and earnout shares are highlighted in green.

Cox et al. (1979), including any simplifying assumptions made specifically for the purpose of valuing EOs.

Structure of a Typical EO

In an EO, the sponsor offers to tie a portion of their promote stake to the performance of the target company post de-SPAC. In a typical de-SPAC transaction, the sponsor's promote stake (set to be 25% of the SPAC's original IPO shares) vests upon the consummation of a business combination. But with an EO clause, a portion of the promote is tied to an EO and does not vest unless the provisions of the EO are met. Though performance targets are sometimes set based on accounting goals (i.e., revenues, EBITDA, etc.) or non-financial performance (e.g., approval of a drug), by far the most common structure uses share price as the relevant performance benchmark. Recall that in a SPAC, shares have a par or book value of $10 each. EO price targets are typically set noticeably or considerably above $10, implying that the sponsor only retains ownership of any EO shares if post de-SPAC performance is decent or exceptional, depending on the price target and time dimension. In our sample, price targets are as low as $11 per share and as high as $50 per share.[25] In terms of timing, we see EOs as short as 6 months out to as long as 10 years. Moreover, EOs can be complex, with multiple price targets and expiry dates. Most EOs have price targets of $12.50 to $15.00, and maturities of two to five years. In order to avoid incentives to manipulate the share price, most EO clauses insist that the post de-SPAC share price must surpass the EO target share price on 20 or more days in any given 30-day period prior to the expiry date of the EO, meaning that a performance target need not only to be met, but *maintained* to qualify for vesting.

The following example of an EO has a structure that is typical of those we see in our sample. A SPAC sponsor creates a SPAC to raise $200M. As such, his promote stake is 5,000,000 shares with a par value of $50M. Suppose that in order to make the SPAC more palatable to all parties, the sponsor agrees to tie half the promote stake to an EO. The EO has 2 triggers, one at $12.50/shr and the other at $15.00/shr. The $12.50 trigger has to be reached within 1 year, while the $15 trigger has to be reached within 2 years. Suppose that half the EO is associated with each price target and each expiry date. Thus, 1,250,000 shares are released to the sponsor if the share price exceeds $12.50 in the first year following the de-SPAC, and another 1,250,000 shares will be released to the sponsor if the share price exceeds $15.00 in the first two years following the de-SPAC. A reminder that in our example, the sponsor retains 2,500,000 worth of promote shares that vest immediately upon the consummation of a business combination. Remember too that though option-like, the EOs are different from options, in that if the trigger price is breached for the requisite number of days the shares vest immediately w/o payment, whereas call options would require payment of an exercise price.

Our Approach

To evaluate our EOs, we follow Cox et al. (1979), hereafter CRR, and construct binomial trees to evaluate the EOs in our sample of SPACs. We evaluate each EO contract based on its terms (trigger price(s) and EO duration(s)) and based on a set of universal assumptions. Specifically, we assume an underlying volatility of the ongoing (de-SPACed) firm of $\sigma = 60\%$ per year and a risk-free rate of 2%. We construct binomial trees with semi-annual periods if the maturity of EO, T_{EO}, is within 5 years, and annual time-step if $T_{EO} > 5$ years.

Following CRR, and with the above assumptions, we define u and d, the returns in the "up" and "down" states, respectively, as: $u = e^{\sigma\sqrt{t}}$ and $d = e^{-\sigma\sqrt{t}}$, with $\sigma = 60\%$ and t

[25] Note: one firm has several EO triggers (actually 8 in total, running from a low of $15 to a high of $200/share) that exceed $50, but this is the only firm with a trigger over $50, so not representative. We feel that stating the max as $50 is more informative, though technically not 100% accurate.

equal to either 0.5 years or 1 year, depending on T_{EO}.[26] In this setting, CRR showed that the risk-neutral probability in such a case is given by: $q = \frac{e^{rt}-d}{u-d}$. We treat reaching a given price as equivalent to staying there for 30+ consecutive days, and therefore satisfying the "price maintenance" portion of the EO's payment clause. We use the usual iterative procedure to evaluate the EO, beginning at the EO expiration and working backwards. Additionally, we note that vesting (early exercise of the EO "option") will always occur immediately upon breaching a price trigger.[27]

In this framework, the value at any node, t, where the share price is denoted, P_t, the EO value by $V_{EO,t}$, and the value of the EO in the following period denoted as $V_{EO,u}$ with risk neutral probability q, and $V_{EO,d}$ with risk neutral probability $(1-q)$, the value of the EO at node t will be given by:

$$V_{EO,t} = \begin{cases} P_{t,} & if\ P_t \geq P_{EO} \\ \left[qV_{EO,u} + (1-q)\,V_{EO,d}\right] e^{-rt}, & if\ P_t < P_{EO} \end{cases} \tag{21}$$

By definition, $V_{EO,0} < P_0$ because the manager would always prefer a "free" share to an EO share. We value each EO according to its fundamentals (trigger price and expiry date) and our simplifying assumptions, with the goal of determining the equivalent amount of promote stake that the sponsor has voluntarily given up by tying a portion of their promote stake to an EO. As a means of benchmarking, and to give an example, a 5-year EO with a trigger price of \$15.00, a fairly typical structure, has a value of \$8.98/share when the share price is \$10. This represents a 10.2% reduction in value. Suppose further that the sponsor has tied half of her promote stake to such an EO, we would characterize this sponsor as having given up 5.1% of her promote stake.

As mentioned earlier, among the 88 SPACs whose sponsors agree to tie a portion of their promote to an EO, the average sponsor agrees to tie 40% of their promote to an EO, with the range running from a low of 4.5% to a high of 100% (there are 6 SPACs whose sponsors agree to tie their entire promote to an EO). Based on our volatility assumptions, we estimate that this willingness of the sponsors to tie an average of 40% of their promote to EOs, results in a value loss of about 6.8% of their promote stake, relative to simply retaining the shares.

[26]Note that in our comprehensive dataset of SPACs, the average volatility of post de-SPAC 3-month returns is about 57% , which is considerably higher than a 60% annualized volatility. However, our performance data cover the initial 3-month window immediately following the de-SPAC, which is a particularly volatile period for the newly de-SPACed shares.

[27]Unlike in the case of a call option, the EO does not sustain any "insurance value", in the sense that owning the shares always strictly dominates retaining the EO.